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Predictors of uptake of screening mammography

By Rebecca Crosby, MPH

A thesis submitted in partial fulfilment of the requirements
for the degree of Doctor of Philosophy in Health Sciences

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University of Warwick

Warwick Medical School, Department of Health Sciences

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My personal motivation for this research is my Granny. She presented to her clinician with a lump in her breast and was subsequently diagnosed with breast cancer (BC). The clinicians believe the cancer was present for many years before she finally presented to general practice (GP). For my family it was devastating but I believe she would be extremely proud. Besides, she always wanted a doctor in the family!

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Will. You have helped me countless times through this PhD journey and I could not have completed this without your emotional support or that listening ear. Thank you.

VI Declaration

This thesis is submitted to the University of Warwick in support of my application for the degree of Doctor of Philosophy. It has been composed by myself and has not been submitted in any previous application for any degree.

VII List of submitted papers

Crosby R, Gallacher D, Nduka C, Alkudairy L, Williamson S, Uthman O, Fraser H, Stinton C, Taylor-Phillips S, Johnson S, Clarke A. 2018. Predictors of breast cancer screening uptake: A systematic review and meta-analysis. [Prepared manuscript]

VIII Conference presentations

- P19. Predictors of mammography attendance and informed choice in England. Symposium Mammographicum July 2016 [poster]
- Predictors of mammography uptake. CLAHRC Stakeholder meeting 2017 [poster]

IX Signed statement

I am aware of the University regulations governing plagiarism and I declare that this document is all my own work except where I have stated otherwise.

Signed

Name

Date

VII Abstract

BACKGROUND Policymakers believe mammography uptake is declining; whether there is a decrease, and in whom is not known. There is a wealth of research focussed on single predictors of uptake in mammography such as socioeconomic status or ethnicity. However, there are limited papers investigating global predictors, particularly with an international focus.

AIM The thesis aims to: identify predictors of (1) mammography uptake worldwide and (2) in South-West London; ascertain if patterns of attendance have changed and if so, in whom, and; commence questionnaire development to determine influencers of uptake.

METHODS A systematic search was conducted on six databases in 2016. Two reviewers independently examined the articles using pre-defined inclusion criteria. Random-effects meta-analyses and sub-group meta-analyses were conducted. Mixed-effects logistic models analysed dichotomised cohort data. The questionnaire was developed with a patient and public representative prior to testing. Thirteen cognitive interviews were conducted and analysed using thematic and content analysis.

RESULTS Data from 91 studies met the systematic review inclusion criteria. Marital status, smoking status, insurance status and number of chronic conditions or primary care visits were found to be statistically associated with uptake. Ethnicity, age, socioeconomic status, income, education, housing tenure and obesity were not significantly associated. The database provided attendance information from 406,015 women. Overall, older women had lower odds of attending mammography than younger women. Odds of attending appeared to increase with affluence, disability or a previous recall and were lower in minority ethnic women compared with White women. Few concerns were identified with the questionnaire items. Minor alterations to questions were made in response to data where appropriate.

CONCLUSION Many variable factors influence uptake. The generalisability of the results to a UK population needs establishing. The questionnaire needs further development to establish validity before establishing which women make informed decisions. Future research should evaluate if personalised information, in line with risk status and other known factors associated with uptake, would be beneficial for screening programmes.

[318 words]

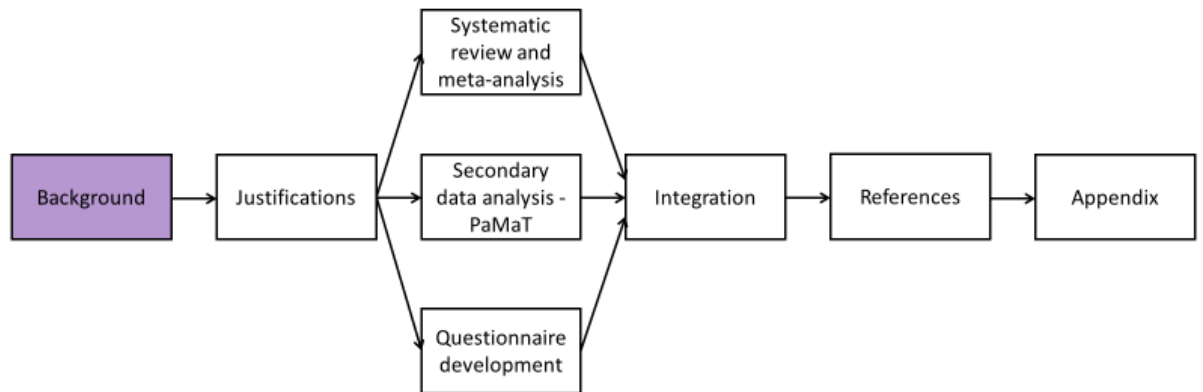
VIII List of Abbreviations

AIC	Akaike's information criterion
AUC	Area under curve
BC	Breast cancer
BCS	Breast cancer screening
BIC	Bayesian information criterion
BMI	Body mass index
BSE	Breast self-examination
BSU	Breast screening unit
CLAHRC-WM	Collaborations for Leadership in Applied Health Research and Care – West Midlands
DP	Decimal places
HBM	Health belief model
HR	Hazard ratio
HRT	Hormone replacement therapy
HSCIC	Health and social care information centre
IC	Informed choice
ICC	Intraclass correlation coefficient
IMD	Index of multiple deprivation
LR	Likelihood ratio
MCAR	Missing completely at random
NBSS	National breast screening service
NHS	National Health Service
NHSBSP	National Health Service breast screening programme
NIHR	National institute of health research
NSC	National screening committee
OR	Odds ratio
PIL	Participant information leaflet
PPI	Public and patient involvement
QAT	Quality assessment tool
ROC	Receiver operator curves
RR	Risk ratio
SA	South Asian
SES	Socio-economic status
SW	South West (London)
T-C	Tyrer-Cuzick
TRA	Theory of reasoned action
TPB	Theory of planned behaviour
UK	United Kingdom
USA	United States of America

Dedicated to Will

*To know that we know what we know, and to know that we do not
know what we do not know, that is true knowledge*

Copernicus



Chapter 1: Background

Introduction

This chapter discusses breast cancer (BC) from a public health perspective and describes its risk factors. It explains what health screening is, with particular focus on the use of mammography for breast cancer screening (BCS). Predictors of breast screening uptake and patterns of attendance are described. Finally, informed choice (IC) is examined and discussed with its relevance to screening.

1.1 Breast cancer

1.1.1 Epidemiology

Breast cancer (BC) is the most common cancer in women worldwide with 1.7 million new cases diagnosed worldwide in 2012 (1). BC accounts for 18% of all female cancers globally (2). BC is the most common malignancy in women in the UK and the second most common cause of death from cancer following lung cancer (3, 4).

There were 55,222 new cases of BC diagnosed in the UK in 2014 which accounted for 11.39% of all new cancer diagnoses (male and female) (5). In the UK, the incidence of BC increased from 66.1 per 100,000 in 1971 to 125.7 per 100,000 in 2010, an increase of 90.1% over 39 years, as shown in Figure 1 (4, 6). The gradual increase is thought to be related to the introduction of the BCS programme in 1987 and the increased prevalence of BC risk factors (7).

In the UK, a woman's lifetime risk of developing BC is 1 in 8, and the majority of diagnoses (81%) occur in women over the age of 50 (3). Since a peak mortality rate in 1986 at 41.7 per 100,000 women, BC death rates have fallen to 24.4 per 100,000 women in 2011 (all rates are age-adjusted) (4). This reduction in deaths could be related to the introduction of BCS, improved treatment options, overdiagnosis or a combination of the three (8, 9).

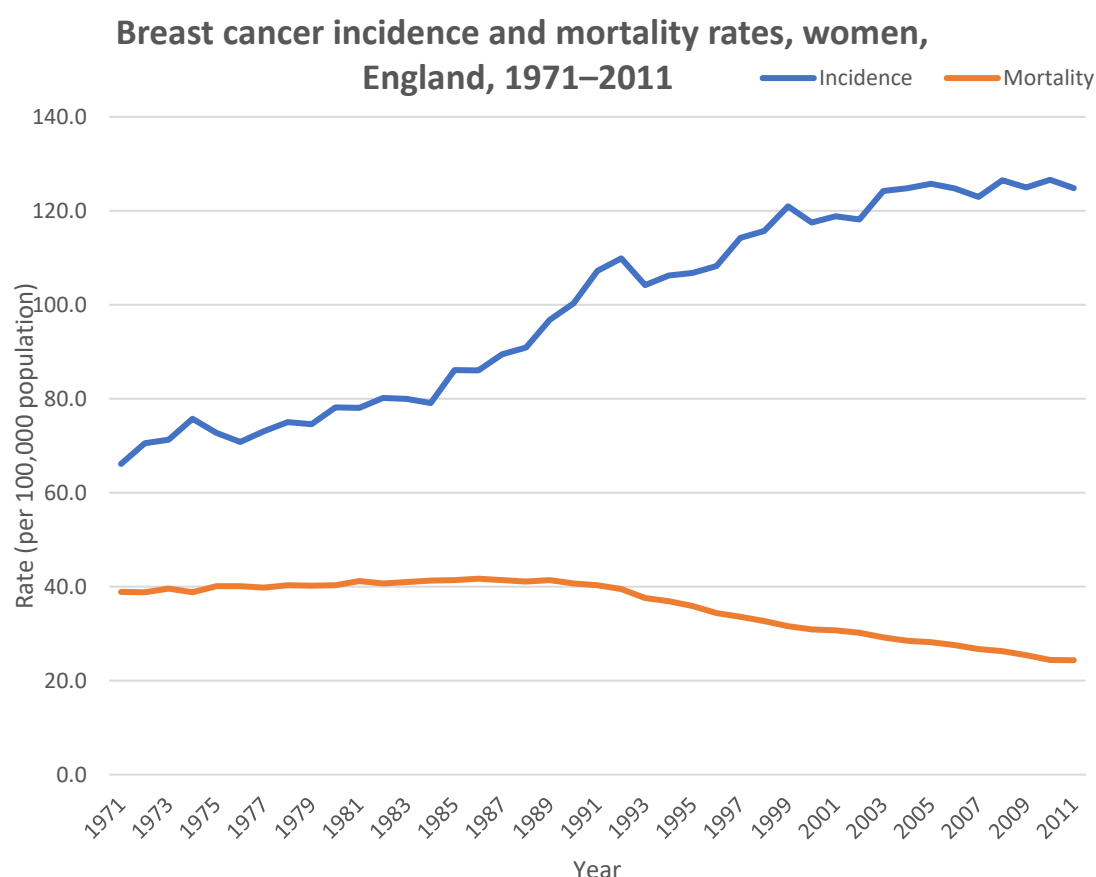


Figure 1. Breast Cancer incidence and mortality rates in England, 1971-2011. Data are taken from 2011 Office for National Statistics release, (4).

1.1.2 Risk Factors

Understanding the risk factors for BC is important. Identifying which women are at higher risk of developing the disease is useful to target public health interventions. Increased awareness of these risk factors and their implications is hoped to help, with the aid of BCS, diagnose BC earlier and subsequently reduce adverse outcomes such as mortality. A number of risk factors have been well reported in the literature as discussed below (10-12).

1.1.2.1 Non-modifiable risk factors

Non-modifiable risk factors are those factors that cannot be changed. BC risk differs by location, with incidence and mortality varying about five-fold between populations globally, for instance between North America and China (13, 14). There is a marked difference in BC incidence between developed and developing countries,

as seen in Figure 2 (15). Mortality rates also vary globally (Figure 3) (15). High rates of mortality are present in countries with seemingly low prevalence of BC whilst the developed nations appear to have lower mortality rates (15).

Among people migrating from low-risk countries to higher-risk countries, individual risk tends to increase and becomes similar to those from the new country (13). This also suggests that BC risk is related to lifestyle factors.

▲ Estimated Breast Cancer Incidence Worldwide in 2012

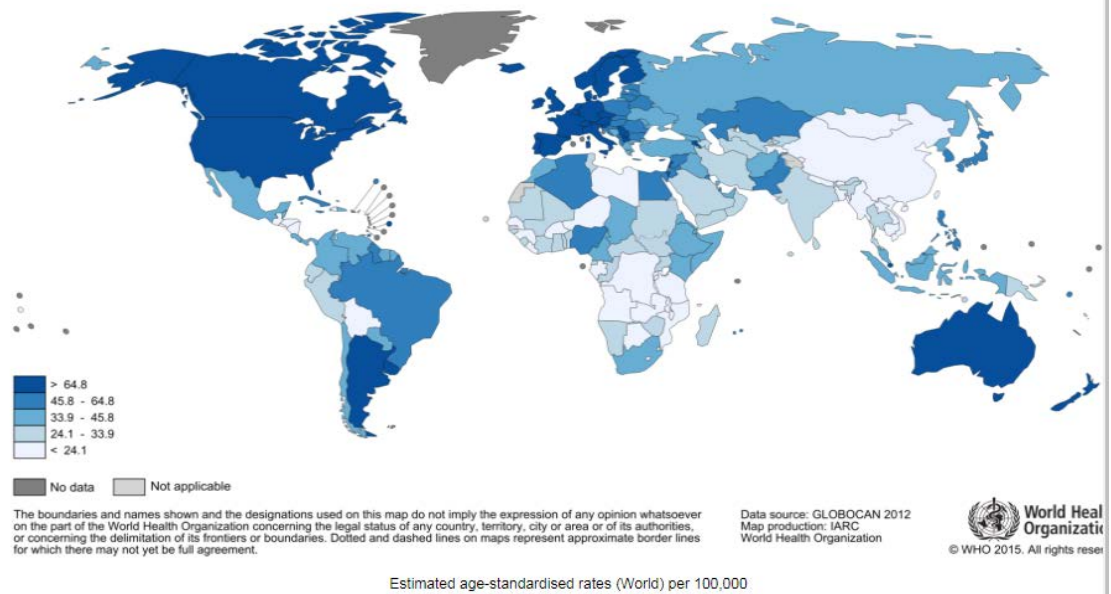


Figure 2. Estimated Breast Cancer Incidence Worldwide, 2012 (15).

▲ Estimated Breast Cancer Mortality Worldwide in 2012

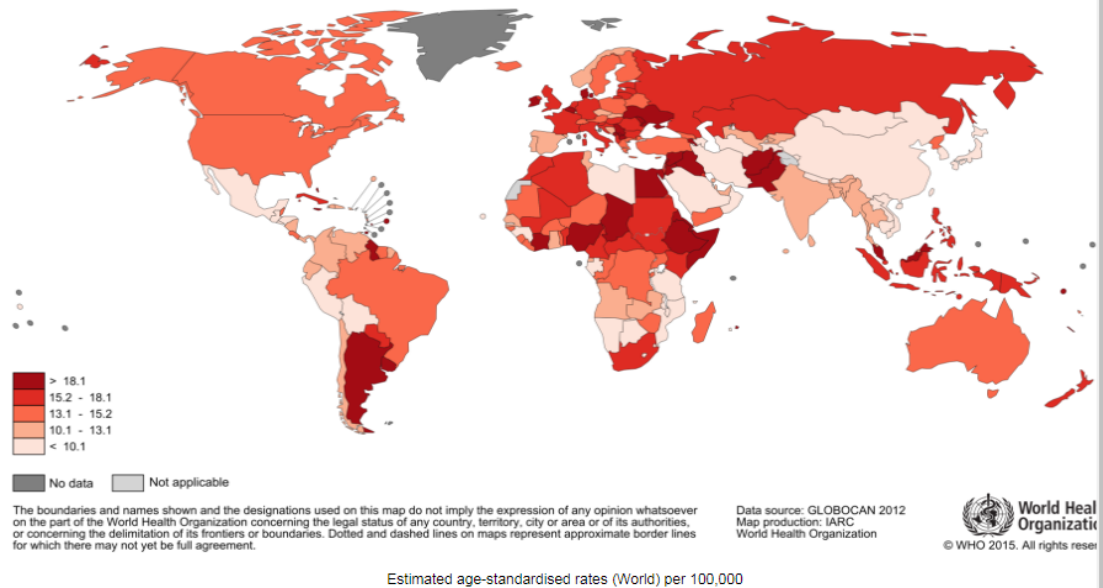


Figure 3. Estimated Breast Cancer Mortality Worldwide, 2012 (15).

Historically, White women have a higher risk of BC (16). However, in 2012 the rates for White and Black African-American women converged in the USA (17). Incidence rates have increased among Asian and Pacific Islander women and have remained stable amongst non-Hispanic White and White women (17). However, African American women still have poor prognosis for BC which may lead to increased rates of mortality (18) perhaps due to poor access of services or social stigma in obtaining help and treatment.

Age is a well-known risk factor for developing BC (2, 13, 14) with peak BC incidence among those aged 75 to 79 years (19). Women presenting in this age range often have BCs that are slow growing and present with smaller tumour masses that may be easier to treat (20).

Age at menarche, the first occurrence of menstruation, is a risk factor for BC. Women have an increased lifetime risk of BC if the onset of their first menstruation starts before 11 years of age (14). The older a woman is when she starts menstruating the lower her lifetime risk of BC (10, 13). For each one-year delay in the onset of menarche, the risk of developing BC decreases by 5%. A delay is particularly protective if menarche starts after 15 years of age compared with other ages (14,

21). Late menopause increases BC risk (10) by approximately 3% for each year of delayed start (13, 14, 22).

Compared with nulliparous women, a woman who has one pregnancy to full-term has a 25% reduction in BC risk (10, 13). Additional pregnancies further reduce the risk (13). In general, risk of BC increases for women who are older at their first birth (10). One study estimated women having a first child before 18 years of age have one third the risk of those whose first birth is at 35 years or older (23). Another study compared women of different ages at their first birth with nulliparous women. They found if a woman is younger than 20 years at the birth of her first child she has a risk ratio (RR) of 0.72 (95% confidence interval [CI] 0.60, 0.87) and if a woman is 30 years or older she has a RR of 0.93 (0.79, 1.09) compared with nulliparous women (24).

An evaluation of the links between breastfeeding and BC risk is provided in a pooled analysis which reported that the odds of developing BC were 31% lower in women who breastfed for one year compared with women who did not breastfeed, odds ratio (OR) 0.69 (0.50, 0.96) (25). A different study concluded that breastfeeding reduces BC risk by 33% if women have been breastfeeding for 25 months or more and has a larger protective effect for younger (13) and African-American women (25). A collaborative group conducting a reanalysis of previous data concluded the RR of BC is reduced by 4.3% (2.9, 5.8) for each year a woman breastfeeds in addition to a 7.0% (5.0, 9.0) reduction for each birth (26).

Family history is strongly associated with the risk of developing BC. However, the extent of risk varies depending on factors such as type of relative (e.g. sister, mother, grandmother), age of the relative when diagnosed, number of relatives diagnosed and the age of the individual (27). Women with a first-degree relative with BC have at least double the risk of developing BC themselves (2). Individuals with a relative diagnosed at a young age have a higher risk of BC than those with a relative diagnosed at an older age (11).

Mammographic breast density has been frequently found to be a risk factor for BC (28, 29). Breast density is a measure of the ratio of fat to tissue in the breast, seen on a mammogram. In general, younger women tend to have more dense breasts.

Compared with women with a breast density of 10% or less, women with a density of 75% or more have higher odds of developing BC, OR of 4.7 (3.0-7.4) (29). Breast density is a strong predictor of BC risk, and is useful in the prediction of a woman's risk of BC.

1.1.2.2 Modifiable risk factors

Modifiable risk factors are grouped as they are variables that can be altered with a subsequent increase or decrease in risk of developing the disease.

Use of the oral combined-contraceptives is thought to increase BC risk (RR of developing BC 1.24 (1.15, 1.33), $p < 0.00001$) (30). However, after ten years cessation of the contraceptive, risk of developing BC returns to baseline as if a woman had never taken the contraceptive (13).

Many women opt for hormone replacement therapy (HRT) to reduce symptoms of the menopause. Evidence suggests use of exogenous female hormones increases the risk of developing BC. The Million Women Study concluded that current and recent users of HRT are at increased risk of BC (31). The magnitude of associated risk is substantially greater for oestrogen-progestogen types of HRT, RR of BC 2.00 (1.91, 2.09) $p < 0.0001$ compared with progesterone only HRT-type RR of BC 1.30 (1.22, 1.38) $p < 0.0001$ (14). Colditz *et al.* (32) found a causal relationship in post-menopausal women between the use of female hormones such as oestrogens and increased BC risk. The magnitude of increase in BC risk per year of hormone use was comparable to that of delaying menopause for a year (32). Steinberg *et al.* (33) conducted a meta-analysis of 16 papers that found a 30% increase in risk of BC after 15 years of oestrogen use post menopause, RR of BC 1.3 (1.2, 1.6), $p < 0.01$ (33), compared with no HRT use. This was even more pronounced for those with a family history of BC, RR of 3.4 (2.0, 6.0) (33).

Lifestyle is known to influence BC risk. Evidence indicates that modifiable lifestyle factors such as obesity, as measured by body mass index (BMI), diet and exercise, are risk factors for BC (11). These three risk factors can be interlinked.

In post-menopausal women with the smallest waist-to-hip ratio the risk of developing BC was 34% lower than in women with the largest waist-to-hip ratio. This

association was found by pooling cohort data but not adjusting for BMI or weight. In pre-menopausal women however the waist-to-hip ratio was not found to have any significant effect on BC risk (34). In post-menopausal women, another study found a higher BMI is associated with increased BC risk (10).

There is a general association between increased exercise and lower risk of BC (35, 36). White women who report exercising (for at least 30 minutes a day three times a week) have a lower risk of BC than White women who do not exercise (37). This effect of exercise has been identified mainly in White women of European descent, for whom more data is available (38). In America, physical activity (counted as more than two hours per week for the previous year) has been linked to a reduction in BC risk for African American women. The odds of developing BC were 63% lower for African American women with high levels of activity compared to those with low levels, OR 0.36 (0.16, 0.79) (39).

Alcohol is classified as a carcinogen for BC by the International Agency for Research on Cancer (40, 41). Liu *et al.* found that compared with women who consume one to three alcoholic drinks per weekend, women who consume 10 to 15 alcoholic drinks per weekend had a RR of BC of 1.49 (no confidence intervals given), while women who drink 16 to 21 alcoholic beverages had a RR of 2.51, (no confidence intervals given) (42). This risk is linked to the total amount of alcohol consumed, not the type of alcoholic drink. Another study found that compared with non-drinkers, women consuming 35-44g of alcohol per day had a RR of BC of 1.32 (1.19, 1.45) and a RR of 1.46 (1.33, 1.61) for those consuming ≥ 45 g alcohol per day (43). Relative risk increases by 7.1% (5.5% to 8.7%) for every additional 10g of alcohol consumed daily (43). If this relationship is found to be causal, four percent of BC diagnoses could be attributed to alcohol in developed countries (43).

Alcohol consumption and smoking are profoundly correlated; many studies do not account for the confounding of these exposures (44). When limited to analysis of only non-drinkers, there was no association found between smoking and BC (43). Other papers concluded similar results highlighting the lack of effect of smoking identified in the aetiology of BC (2).

However, a Canadian paper published in 2015 has found a link between active smoking and BC risk (45). Duration, intensity and cumulative exposure are all found to increase hazard ratios (HR) of BC development. Those who have been smoking for 40 years have a HR of 1.57 (1.29, 1.92) compared to non-smokers. Women smoking 40 cigarettes a day versus non-smokers have a HR of 1.21 (1.04, 1.40) and those with a 40 pack-year history vs zero have a HR of 1.19 (1.06, 1.13) (45).

Some influencing factors can be interlinked and are often confounded with multiple different factors. For instance, ethnicity and geography could be interlinked or to some extent migration could be explained by personality type. However, for demonstration purposes the influencing factors have been presented in the figure below as modifiable or non-modifiable.

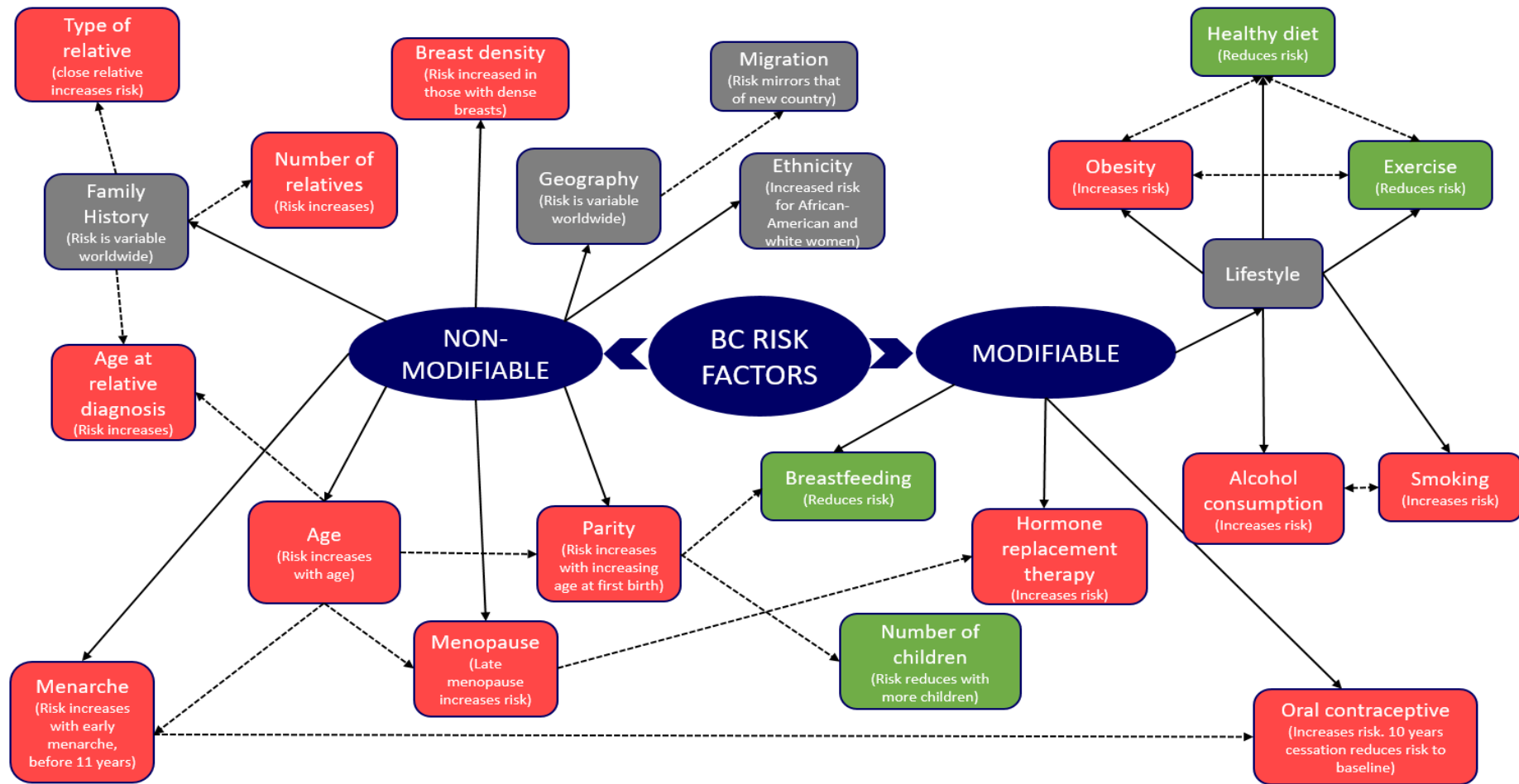


Figure 4. Summary diagram of risk factors for BC (2, 10, 13, 14, 23, 25, 27-33, 35-39, 42, 44-46). The colours represent varying risk levels, factors shown in red are associated with increased risk of BC, those in green are associated with a reduction in risk and those in grey are associated with variable risks. Solid lines represent direct influencing factors. Dotted lines represent those that are linked to other influencing factors, for instance parity is a factor on its own but risk also increases with age at first birth.

1.1.3 Risk prediction modelling

An individual's risk can be estimated using their personal information and comparing this to statistical averages from the population. A risk prediction model commonly uses demographic, lifestyle and personal health information to estimate the probability of an individual woman developing BC.

Trials have begun to investigate the outcomes of predicting risk of BC and adopting a more personalised approach. However more work is required to understand how risk is understood and perceived by the public. The PROCAS study (Predicting Risk of Cancer at Screening) used the Tyrer-Cusick model to explore the effects of their risk knowledge on women participating in screening (47, 48). The major limitation of this study was that it only used women who attended screening and like with any study would therefore be biased in those who participated in the programme. Furthermore, due to space restrictions, the questionnaire for risk assessment did not collect information on female relatives without BC which can be an important factor in risk prediction. No harms were associated with providing women with their 10-year risk estimate and most women were satisfied with the information provided however there was considerable variation in understanding (48).

Women with high mammographic density were found to have higher risk of BC than women with predominantly fatty breasts. Measurement of density has changed dramatically in recent years with the advance of technology. However, visual assessment of mammographic density requires a skilled worker and is time consuming. Automated processes have also become available recently but there are concerns for their cost and reliability (49). For these reasons the use of mammographic density has never been widely adopted in everyday practice (47, 49). Perhaps if an automated system was developed it could be incorporated into the NHSBSP system.

Popular prediction models include the Gail Model (50) and the Tyrer-Cusick (T-C) Model (10) which use the additive effect of many different risk factors from personal information and hormonal or reproductive factors to personal breast disease and family history to create an overarching risk estimate (11). Other risk prediction model

options include Claus, BOADICEA or BRCAPRO which do not include as many risk factors in their risk assessment and do not appear to perform as well with low observed-expected ratios (47). The T-C Model has been chosen for use within this thesis as it is the most consistently performing model (11, 46) and this choice of model is discussed further in the questionnaire development study section.

Whilst these risk prediction models are not currently used in the NHSBSP screening programme, research is starting to investigate the effect this may have on identification of those at higher-than-average risk and for whom a preventative intervention or more intensive surveillance may be appropriate (51). This seems to be an interesting field for future research to enable them to be used effectively in screening programmes.

1.2 Health screening

Health screening is a public health tool in which seemingly healthy members of a pre-defined population are asked questions or invited to complete a test to determine if they are at higher than average risk of having a disease/condition (52). Put simply by Zavon *et al.*, *'screening tests sort out apparently well persons who probably have a disease from those who probably do not'* [p. 349] and can identify individuals in the early or pre-symptomatic stage of the disease (53).

The 'Wilson and Jungner' criteria were developed as a result of their report for the World Health Organisation in 1968 and provided the first clear evidence and principles to underpin the practice of screening (52, 54). In the UK, these have since been extended to twenty component criteria with which to appraise the validity, viability, effectiveness and appropriateness of screening programmes including emergence of criteria to ensure informed choice (IC) and respect for patient autonomy (54).

The classic screening criteria proposed by Wilson and Jungner (52) fall into four sections: the condition, the test, the intervention and the screening programme. They propose the condition should be an important health condition. There should also be an accepted treatment for patients with the disease with earlier treatment being more beneficial. This treatment should be acceptable to the population. For a

screening programme to be implemented there should be a recognisable early symptomatic stage and a suitable test or examination to detect this stage that is acceptable to the population and there should be an agreed policy on whom to treat as patients and the cost of case-finding should be economically balanced.

There were 1.7 million new BC cases diagnosed worldwide in 2012 making it undeniable that BC is an important health condition (1). Whilst the examination and treatment appear to be acceptable to most of the population, BC mortality rates have not decreased as expected in locations where mammography screening is in place (55-57). Furthermore the influence mammography may have on mortality rates has likely decreased in-line with increasing efficacy of cancer therapies (58). Whilst mammography screening was implemented in review of the current evidence, further research has been conducted that may contradict previous thoughts, including on the debate about overdiagnosis which shall be discussed in greater detail below (58).

These basic criteria have been further extended to include the requirement that the programme ensures informed choice (IC), confidentiality and respect for autonomy (52). There should be a defined target population and the programme should have quality assurance measures in place to maintain standards. The overall benefits of screening should outweigh the harm, some of which have been discussed in Section 2.5, but this is a controversial matter and still considered debatable (59-61). Further work needs to investigate the effect of promoting IC in a screening programme, following the example set in Germany, particularly in respect to uptake rates (62).

1.2.1 Breast Cancer Screening (BCS)

The Breast Cancer Screening (BCS) programme was introduced in England in 1987 to aid the early detection of BC at a population level. It is a mass screening programme which aims to reduce mortality from BC by detecting and treating the disease earlier. Note, this BCS programme is not the same as the programme for those known to be at higher risk, such as women with previous breast disease history or familial BC.

Women in the UK who are registered with a GP are invited by appointment letter, accompanied by a patient-information leaflet which explains the positive outcomes

of breast screening and potential harms (63). Results from the mammogram are posted to the woman's home and copied to the GP within two weeks.

BCS consists of an initial x-ray (*i.e.* mammogram) taken of each breast. To obtain a clear image two views (angles) are taken whilst the breast tissue is compressed between two plates. At this first appointment 96% of people receive a negative result, indicating no BC is observed, and are not contacted for another three years. Four percent of women receive a positive result and are offered further tests and procedures to determine whether they have BC. This second set of tests and procedures includes either a diagnostic mammogram, ultrasound or guided needle biopsy with/without fine needle aspiration. These phases are shown in Figure 5 below.

When a woman attends breast screening, there are four possible test results from the mammogram: true positive (TP), true negative (TN), false positive (FP) and false negative (FN) and these are shown below in Table 2. But there are other outcomes of having a mammogram, *e.g.* positioning or technical failures resulting in recall without a result.

Approximately four percent of women who attend breast screening are recalled for repeat mammography and possible biopsy (64).

Table 1. Outcome of Screening Tests

		The "Truth"	
		Diseased	Not Diseased
Test Result	Positive	True Positive (TP)	False Positive (FP)
	Negative	False Negative (FN)	True Negative (TN)

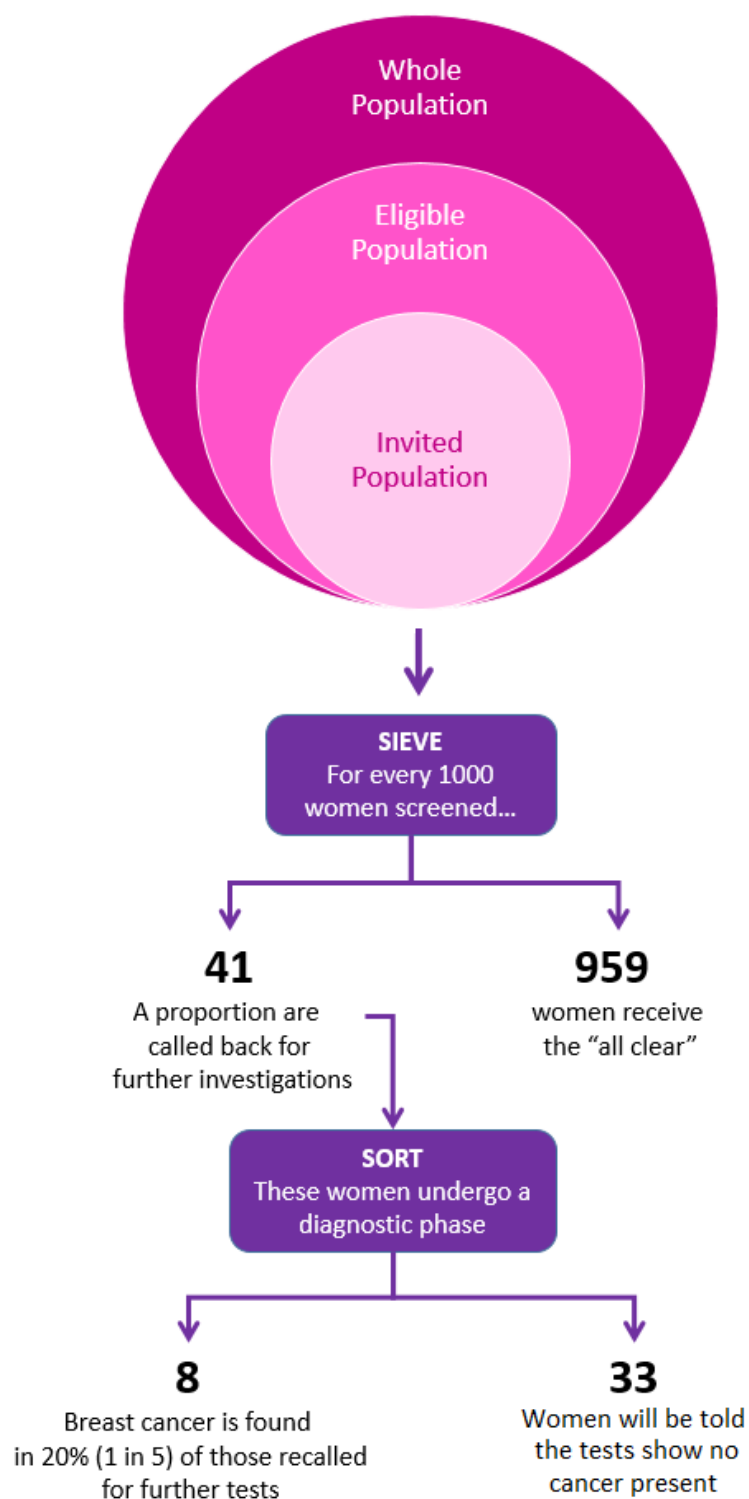


Figure 5. Sieve and sort process in National Health Service Breast Screening Programme. Eligible population consists of women registered with a GP in the UK and aged between 50 and 70 (47 and 73 in some areas). The invited population may be smaller than those eligible due to poor records of addresses and contact details (65). Coverage = eligible population/whole population X 100. Uptake = attended population/eligible population X 100 (66). Source adapted from (54).

A positive result is discussed at multi-disciplinary team meetings to determine if the recall is due to a BC and if the patient requires treatment. These meetings use a combination of opinions from the physician assessment, mammogram and biopsy results to ensure maximum efficiency at discovering all potential BCs. If all three indicate cancer, there is a 98-99% likelihood that this is a true BC (64). However, of the women recalled, 3.3% are FP results equating to approximately 63,000 women annually (67). Alongside the inconvenience and disruption, this has psychological consequences such as anxiety, even for those who are given the “all clear” at recall (67). For some women, this anxiety about test results persists for up to 12 months (68).

The screening age range in the UK is currently 50-70 years of age but is being extended to 47-73 in some regions as part of the age extension trial (NCT01081288). A previous ‘Age Trial’, initiated in 1991, evaluated annual screening for women from 40 years of age until 47-48 years prior to the population screening programme (69). The trial did not lead to a significant reduction in mortality in those who attended, RR of mortality 0.83 (0.66, 1.04), $p=0.11$ (65). The current extension of the screening age range in the UK is controversial with little evidence promoting its adoption or verifying that it is beneficial to screen these additional age ranges, particularly within the younger age group (70).

The popularity paradox indicates *‘the greater the harm through overdiagnosis and overtreatment from screening, the more people there are who believe they owe their health, or even their life, to the programme’* (p. 68, (54)) and of course those who believe they owe their life to screening are avid supporters of it. Because of this, it will be extremely difficult to reverse offering population screening to the additional age groups even if there proves to be little evidence of benefit (54, 70).

The ways in which screening programmes are delivered vary around the world, as was shown in Chapter 1. Many countries screen women from a younger age and screen them more frequently, commonly biennially. For example, Canada screens women annually between the ages of 40 and 49 and subsequently biennially for

those aged 50 or over. Many countries, including the United States, begin screening women for breast cancer at 40 years of age. This highlights a key difference between national programmes. This may be because risk varies worldwide, or it could be because there is no clear evidence for an effective regime for BCS.

1.2.2 The debate about health screening - advantages and limitations

As with any healthcare procedure there are advantages and limitations. Much of the evidence used in the BCS debate relies on randomised controlled trials that were conducted decades ago. These trials may not reflect the current screening process because they preceded the treatment and healthcare advances which affect BC mortality and outcomes today. The benefit observed previously for BCS may be more limited now (67, 71).

1.2.2.1 Early detection

Screening is beneficial in many ways, its biggest achievement being that it can detect BC before symptoms occur. BCS ultimately aims to reduce mortality (72). It is known that identifying BC at this early stage improves chances of successful treatment and remission (73).

A meta-analysis of three randomised trials (excluding the Edinburgh trial due to issues with reliability (68, 74)) comparing invited women against control women calculated an overall RR of 0.80 (0.73, 0.89) for developing BC (67). However, other authors have arrived at different risk estimates and conclusions (75). Whether or not benefits outweigh the harm is disputed, as there are a number of harms and negative aspects to BCS that will be discussed below. In an update of the 2006 Cochrane Review, the three trials were re-analysed and did not show a reduction in BC mortality at 13 years RR of 0.90 (0.79, 1.02) (76).

1.2.2.2 Inequalities

The UK National Health Service Breast Screening Programme (NHSBSP) provides nationwide BCS that is free at the point of care. It does this with the aim of reducing health inequalities so that every eligible woman in the appropriate age categories who is registered with a GP and who wants to be screened, can be screened. However, not everyone who wants to attend can attend screening. Some women still

struggle to attend due to financial, emotional, accessibility or language barriers (75). This can contribute to and exacerbate health inequalities as women who attend screening are more likely to take an active role in disease prevention and are generally healthier than those who do not (77, 78). This is termed the “healthy screenee effect” and is known to make screening appear more beneficial than it appears (77).

Inequalities are present within the NHS healthcare system and early detection of BC is no exception (79). Inequalities exist and show an inverse association between mortality and social class as discussed in many health inequality papers but especially by Marmot *et al.* (80). Uptake rates in different types of women are discussed more below.

A lower incidence of BC is reported in lower socioeconomic status (SES) groups as shown in Figure 6 yet they have a higher rate of mortality (81). The same pattern is found in Black and Asian minority ethnic women (82). Despite a lower incidence of BC, minority ethnic women have a higher rate of mortality (82, 83). This could be due to a lower uptake of BCS, as disparities in uptake are reported (82) or to some other factors.

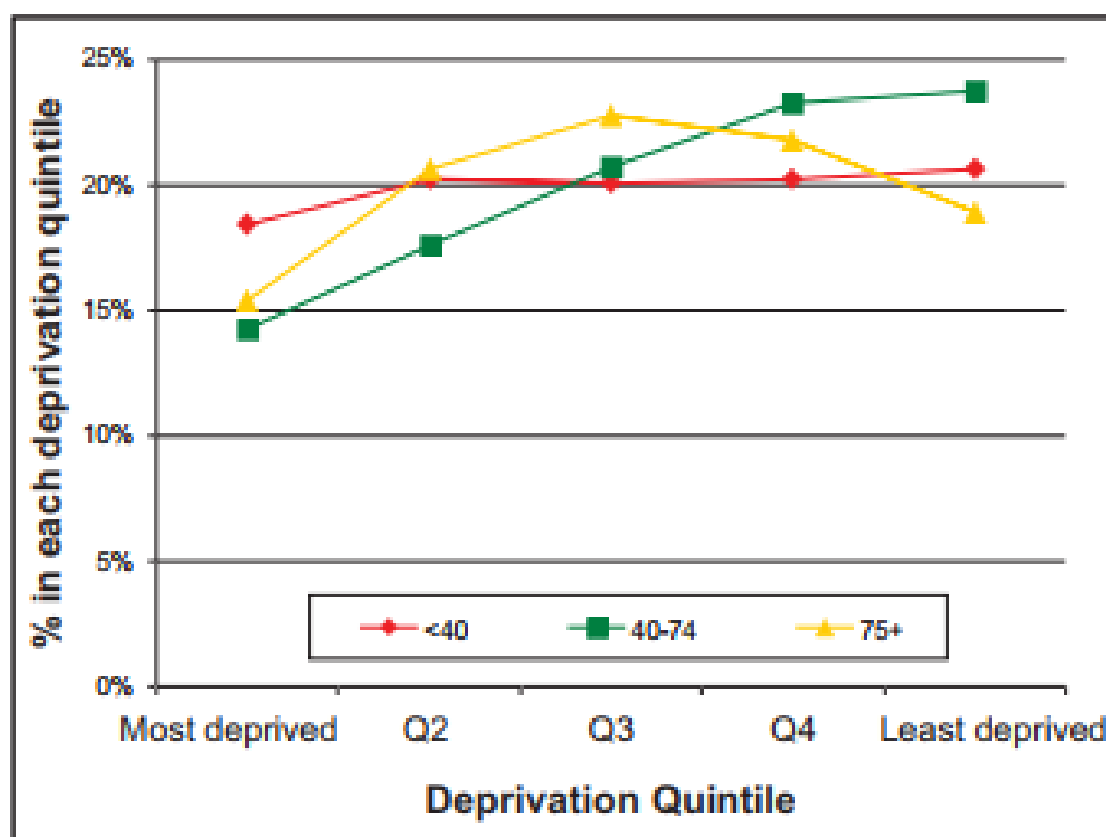


Figure 6. Variation in deprivation status with age at diagnosis for all women diagnosed with breast cancer in England, 2007. Source taken from (81).

Decreasing health inequalities is a matter of justice. Marmot recommends not solely focussing on the least affluent but increasing the health of all, with a focus on those with most need (84).

1.2.2.3 Overdiagnosis

Screening sometimes finds BCs that would never have caused a woman harm during her life. This is termed overdiagnosis and turns people into patients unnecessarily and may lead to treatments that do more harm than good for the individual. Overdiagnosis must not be confused with false positive results.

Overdiagnosis within BCS may be due to one of two things, either the abnormal cells meet the criteria for a cancer diagnosis but never progresses (or even regresses contrary to expectation), or the cancer progresses slowly enough that the woman dies of other causes before symptoms appear as seen below in Figure 8 (85). Thus,

even a rapidly growing tumour may be termed overdiagnosed if the woman is near the end of her life. With overdiagnosed BCs the diagnosis is correct in that the tumour mass, histology and symptoms do reach the criteria for cancer. The challenge is that not all BCs end up being detrimental to health and clinicians cannot know at the time of diagnosis which tumours are overdiagnosed and subsequently all cancers are treated as if lethal (85).

The diagram below summarises the proportions of events with and without screening. This information is not found in the screening leaflet (72). It shows that mammographic screening has only small population benefit overall (one fewer death) and could instead be risky for the individual (three extra women are treated). Furthermore, three women are unaffected by the BC they develop and are not treated for in the 200 women who were not screened.

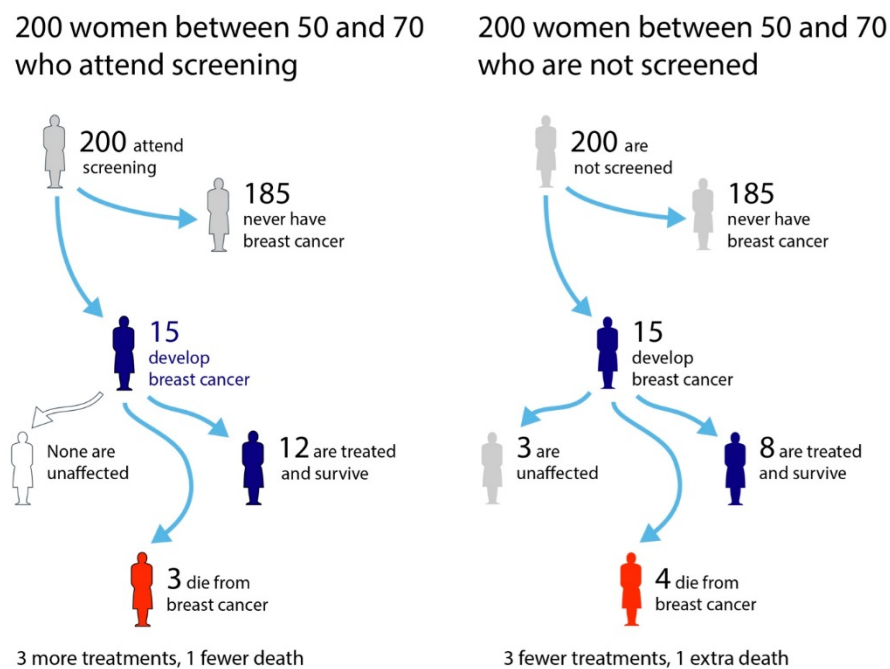


Figure 7. Outcomes of Breast Cancer Screening. Source from (72).

Rates of overdiagnosis are difficult to estimate and the literature still provides conflicting numbers (86). Duffy *et al.* estimated that for every eleven cases diagnosed, two lives were saved and one woman was overdiagnosed (87). The Independent UK Panel on Breast Cancer Screening estimated overdiagnosis to be

19.0% (15.2, 22.7). This suggested that for those invited for screening over a period of 20 years since the age of 50, one life would be saved for every three women overdiagnosed (67, 71).

Arguably, overdiagnosis is the most important harm associated with early detection of cancer. As per the NICE guidelines, after a diagnosis of BC the patient is commenced on a structured regime of chemotherapy, radiotherapy, endocrine therapy and/or surgery depending on the type of BC diagnosed (88). This means overdiagnosis can result in overtreatment. This treatment phase is commonly accompanied with anxiety which can have significant negative and long-lasting effect (85). The harms have become a common issue of debate, *'the impact is long-lasting and affects patients' sense of well-being, ability to get health insurance, physical health and their life expectancy'*(85).

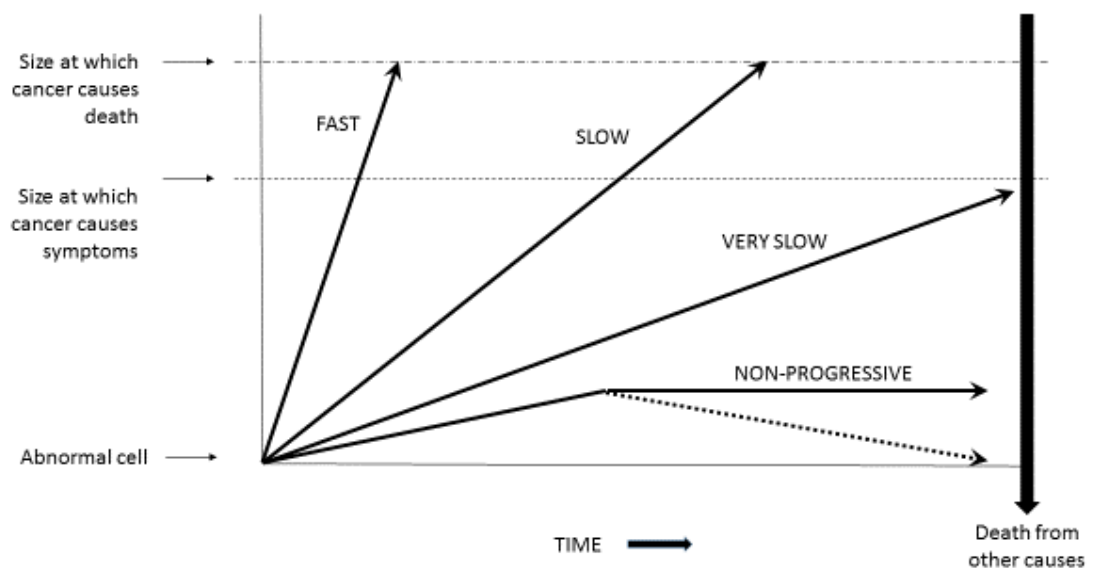


Figure 8. Heterogeneity of cancer progression from diagnosis. 'Fast' indicates a fast-growing cancer that often quickly leads to symptoms and death. This type is often not detected by mammography screening and is classed as 'interval' cancer (detected between screening rounds) as seen in length time bias (54). The 'slow' arrow represents a cancer that leads to symptoms and death but only after many years. The 'very slow' is a malignancy that never causes a problem because the woman will die of a different reason before this type of cancer is large enough to cause symptoms. The 'non-progressive' type represents cellular abnormalities that meet pathological 'cancer' definition but never create any symptoms and may even regress back to normality (dotted line). The 'very slow' and 'non-progressive' cancers are termed overdiagnosed cancers. Figure sourced from (85).

BCS in the UK was set up shortly after publication of the Forrest Report in 1986. This emphasised the need in the UK for BCS (89). This report included evidence from two trials at the time (New York and Two-County) which did not fully consider overdiagnosis (59).

A 2005 review by Moss and colleagues investigated overdiagnosis based on data from global trials (90). Gotzsche *et al.* critiques this review claiming it is limited by its inclusion of data from studies that were methodologically flawed (59). Duffy *et al.* published five papers between 2003 and 2006 analysing the available data and found little or no evidence of overdiagnosis. Rates ranged from 1% in the Two-County trial and Gothenburg (8, 91) to 5% in Copenhagen and Florence (9, 92) and 4% in an analysis of diagnoses at the incident screen (93). They concluded that these estimates are 'subject to considerable uncertainty' and that more research is required to investigate a more precise estimate of how much overdiagnosis occurs (8). However, more recently Duffy *et al.* have analysed the Swedish Two County Trial of 55,985 women and argue that at twenty years post screening, the number of lives saved outnumbers the number of cases overdiagnosed at 0.88% and 0.43% respectively (87)

Conversely, Gotzsche *et al.* has published studies showing evidence of overdiagnosis in the region of 30% (59, 94). For every 2000 women invited for BCS over ten years, it is estimated that one will have her life prolonged by treatment, but ten healthy women will be treated unnecessarily (94). This can be translated into: one out of every three BCs detected in a mass screening programme will be overdiagnosed (95). A systematic review published in 2009 suggests rates of 52% overdiagnosis in BCS (95). A key limitation of this review by Jorgensen and Gotzsche is the limited sources examined; the researchers only searched PubMed and this might not necessarily be exhaustive.

The Marmot Review states that BCS reduces deaths but that some overdiagnosis occurs, suggesting that it is in the region of '*one BC death ... prevented for every three overdiagnosed cases identified and treated*' (96).

The Malmö trial was randomised at the individual level, contained 235,000 participants and was conducted for longer than any other mammography trial. The oldest cohorts were not screened and remained as controls throughout the follow-up period. This provides a reliable control group which is unusual for screening trials. Zackrisson *et al.* indicate, using the Malmö trial data, that there is a 10% rate of overdiagnosis found (97).

Similarly in the UK, as shown in Figure 9, the observed incidence of BCs diagnosed in the 50-64 year age group was found to increase after the introduction of screening of this group. Gotzsche *et al.* found the same occurred for the 65-70 year age group however this is not shown graphically here (59). This evidence cannot reliably discriminate between substantial overdiagnosis or an increase in the incidence of breast cancers making them detectable in older women.

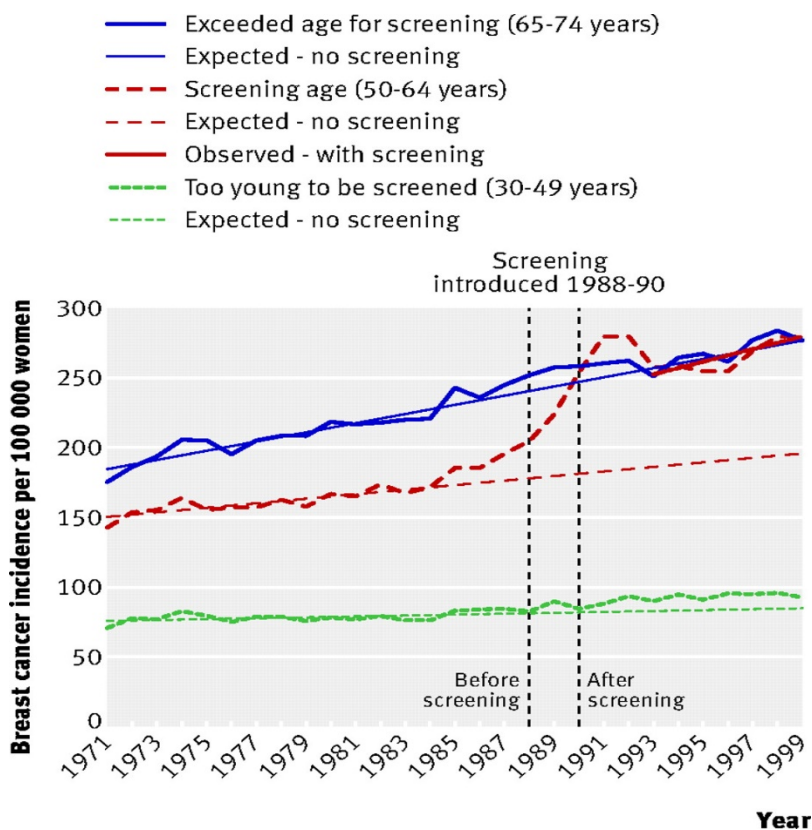


Figure 9. Incidence of BC per 100,000 women in the UK by age group. Dashed lines: expected incidence without screening. Figure by Gotzsche *et al.* (59, 95).

The pattern of increasing BC incidence found in a setting of stable death rates (Figure 10) and no change in overall mortality reduction is suggestive of overdiagnosis (85).

Nevertheless, as the differing systematic reviews suggest, there is no current consensus about how much BC overdiagnosis occurs as a result of screening (93).

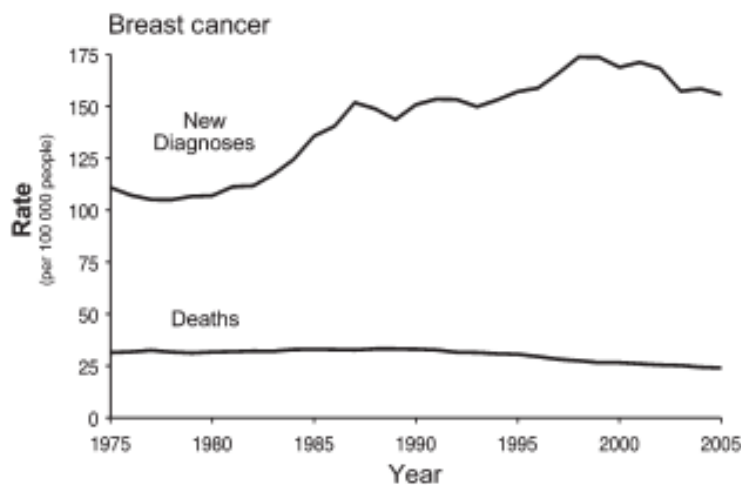


Figure 10. Incidence of BC in the setting of stable death rates per 100,000 population. Figure sourced from (85).

1.2.2.4 Pain and psychological impact

The invitation to mammography that each woman receives briefly mentions that ‘some women experience pain’. It is important to note that this pain is cited as a reason for some women to delay, defer or cancel reattendance (63, 94, 96, 98).

As stated above, approximately 4% of women are recalled for repeat mammography and possible further investigation such as biopsy. Seventy percent of these women will have further imaging and 30% a biopsy, though only 20% of these recalled women will eventually have a cancer detected (96). This recall process coupled with further, somewhat intrusive, procedures can also cause psychological distress which can last for up to 12 months (96).

Brett *et al.* found that of women who were recalled for further investigation, significant anxiety and adverse psychological impact remains at the three-yearly recall. The risk of women experiencing a psychological consequence at one month before their recall screen was 107% higher for women who underwent a surgical biopsy compared with those who did not, RR 2.07 (1.22, 3.52), $p=0.014$ (99).

A UK review in 2012 found that compared to women receiving a negative result, women with a false-positive result had a statistically significant reduced likelihood

(RR 0.97 (0.96, 0.98)) of returning for further screening rounds as a result of negative psychological impact (100).

In 2016 a review was written to update the US Preventative Task Force (USPSTF) recommendations by Nelson *et al.* (101). This review incorporated four systematic reviews and ten observational studies examining the psychological effects of screening. Results show that those who had a negative result which was clearly communicated to them exhibited minimal anxiety, but those who were recalled without clear communication had longer-lasting anxiety and distress (101). It is of further concern that although they are not individually possible to identify in advance, some of the women undergoing these follow-on tests and treatments will have an overdiagnosed cancer and will never obtain benefit from the recall.

1.2.2.5 Bias

Any screening programme will have biases. Lead time bias is where cancers are detected at an earlier time point, although no treatment benefit is experienced. Length time bias is where slow growing, less dangerous cancers are more likely to be detected than fast, aggressive tumours due to the intervals between screenings. These biases can skew the evidence on the performance of screening programmes to suggest more 'favourable' results when analysing survival post diagnosis. These biases in addition to the "healthy screenee" bias previously described make evaluation of screening programmes complicated.

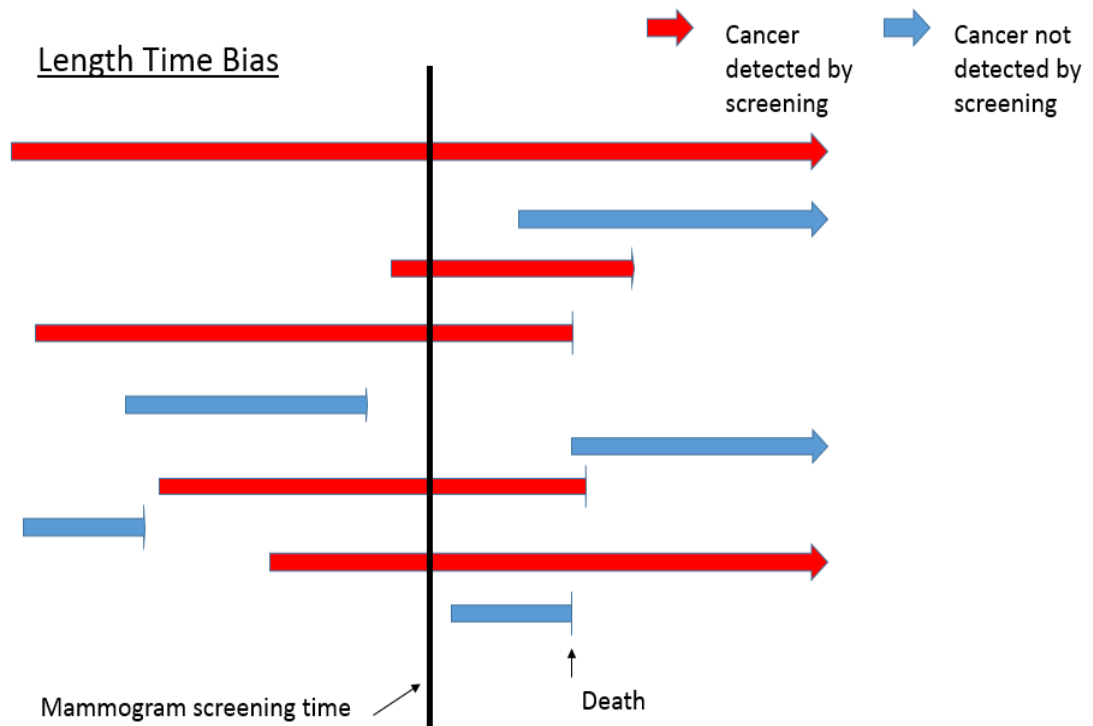


Figure 11. Length time bias. Source adapted from (54).

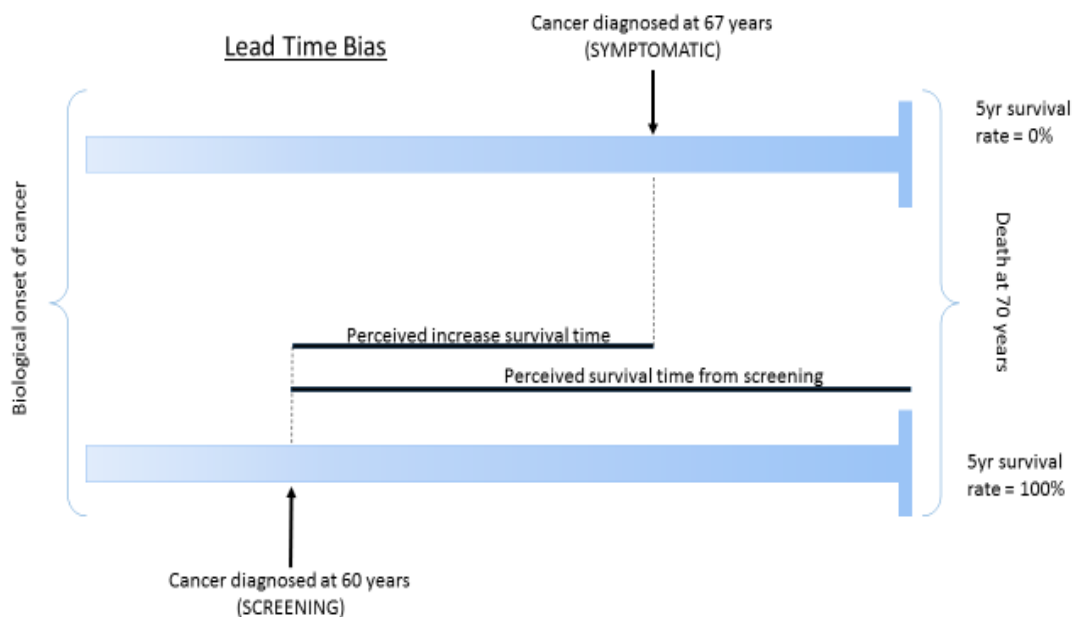


Figure 12. Lead time bias. Source adapted from (54).

Additionally, the “popularity paradox” is recognised where the benefits of screening are more apparent than the harms. For example, a woman who has a BC detected by her mammography screen is likely to have a slower-growing, less-aggressive tumour (length time bias). These cancers are more likely to be easy to treat and the woman

and her family and friends will notice that she may experience a longer period in remission. The woman may then feel, perhaps mistakenly, that she owes her life to screening and would thus advocate BCS more strongly to the women in her social circle. In reality the tumour that was detected and treated may not have ever caused symptoms or caused her harm (85).

Every public criticism of screening has to be countered with ever more positive assertions in order that public confidence is not shaken (102).

In summary, the decision about whether or not to be screened remains a balancing act for each woman, balancing competing conflicting priorities with incomplete information. On an individual level, a woman attending screening will not know when or whether she has been overdiagnosed and overtreated. Equally if she did not attend she will not know whether she would die from a cancer that could have been detected earlier by screening, and therefore treated. Problems with this approach are discussed later in the section titled Informed Choice (IC).

In my opinion it is more important to focus on improving knowledge mobilisation and transparency of screening information in order to obtain IC from women invited to attend. Ultimately, ensuring IC from women will take more effort than providing an information leaflet. However, this approach could lead to a personalised approach to BCS rather than the “one size fits all” style we have adopted currently (103). For this to be implemented more research is required to evaluate who currently attends and who does not, who makes an IC now, and whether making an IC influences attendance at screening. From these results we can then decide on next steps and implementation into personalised practice.

1.3 Uptake

1.3.1 Health behaviour theory

One of the most popular theories used when researching predictors of health behaviour (including screening uptake and smoking cessation) is the theory of planned behaviour (TPB), seen below in Figure 13. This is an extension of the theory of reasoned action (TRA) and attempts to account for personal behaviours. These

theories have been used to explore behaviours such as binge drinking, participating in more exercise and other screening behaviours (104-107).

A central component of the theory is the intention to perform the behaviour (as discussed below, this is a strong predictor of uptake). This idea that a behaviour depends on motivation (intention) and ability (behavioural control) is not new and is seen throughout the literature investigating predictors of uptake (108). However, this theory relies on the behaviour being rational which is not always thought to be the case (109).

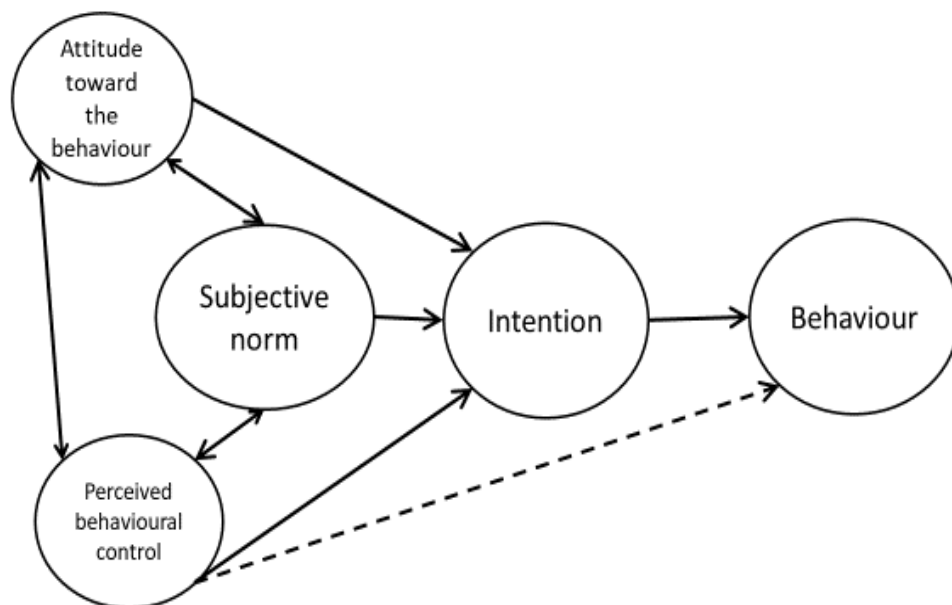


Figure 13. Theory of Planned Behaviour (TPB). Source recreated from (110).

The health belief model (HBM), shown below in Figure 14, indicates a health-related action relies upon three types of factors which include individual perception, modifying factors and likelihood of action (111). The HBM proposes that an individual needs to perceive a threat to calculate benefits versus costs involved in participating. The HBM also considers that this perception of a threat is dependent on individual factors such as demographics, psychosocial influencers and the media, and/or social pressure for action or inaction (111). However, the HBM fails to account for self-

efficacy or whether the individual perceives themselves able to participate in their chosen behaviour, and this could be a key limitation of the model.

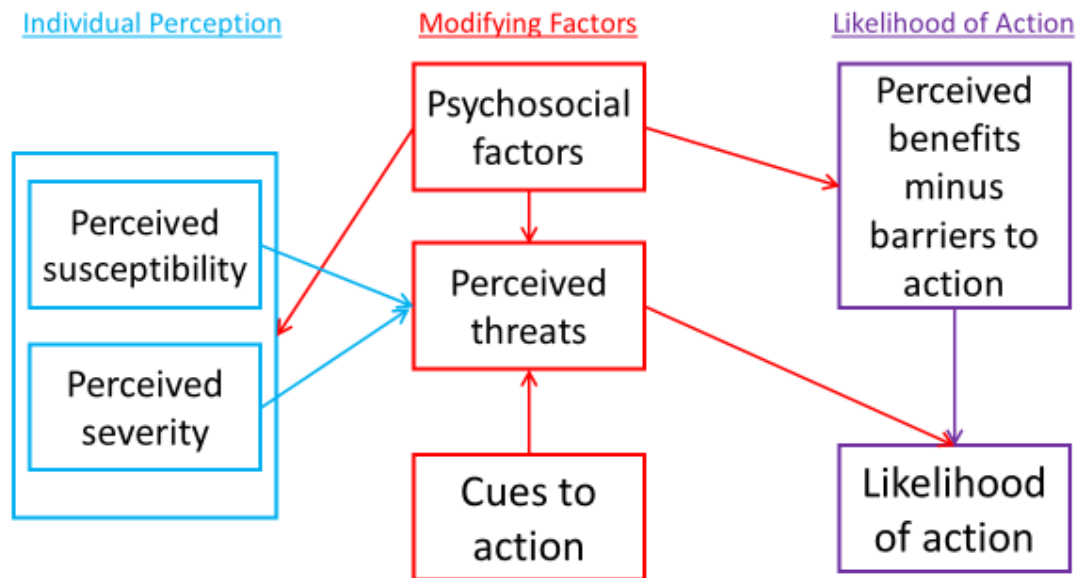


Figure 14. Health Belief Model (HBM). Source adapted from (112).

The main behavioural theories incorporate perspectives related to biomedical, behavioural, communication, cognition and self-regulation. Each perspective is a complex combination and dynamic phenomenon that not only relates to the health system and behaviour under consideration but also to the socio-economic and demographic contexts each woman is in.

The HBM bases health behaviour change as a rational appraisal of the balance between barriers and benefits to action. Although not explicitly stated, it assumes that variables are not moderated by each other and have an additive effect. The HBM also assumes that variables remain unmoderated by behavioural intention (113). Nevertheless, each model has its strengths and limitations.

The contributing factors of attendance

Evidence suggests that non-attendance is not uniformly distributed among the eligible population (114). Attendance at screening is an individual's decision (behavioural) which is affected by the accessibility of the service (structural) and by

a woman's immediate surroundings (societal) (115). These factors indicate where inequalities in uptake may exist.

A woman must consider a wide variety of influences on her decision to attend mammography. These are discussed further in the sections below. These influences include social, psychological and demographic factors that combine into a complicated network. Some influences may not manifest themselves as conscious decisions and may subliminally sway a woman's decision or likelihood of participating. Variables which have been associated with screening attendance can be grouped into a number of categories: 1) socio-demographic characteristics; 2) personal health status and history; 3) other health behaviour and use of medical services; 4) beliefs, attitudes and knowledge about cancer and screening; 5) intention to participate; 6) accessibility and logistics; and 7) social influences and support (115).

1.3.2 Sociodemographics

Age has been found to relate to uptake in many studies, with increasing age associated with lower uptake (75, 116-123). In 2000, Edwards *et al.* researched factors affecting attendance in a Welsh cohort of women. From a sample of 1,604 women 16% of those aged 65-69 years attended screening, 6% of those aged between 70 and 79 and only 3% of those aged over 80 years attended BCS (118). Whilst women over 70 years are not invited to the organised screening programme in the UK, they are still encouraged to attend BCS if they suspect a BC but this trend needs caution as it might not be generalisable to the UK organised screening population. This trend is seen outside the UK. In Lebanon, trends in mammography utilisation were studied between 2005 and 2013 and this study found a consistent trend. Women aged 50-59 attended most frequently, whilst older women over 60 category had lower uptake rates (123). This is shown in the graph below.

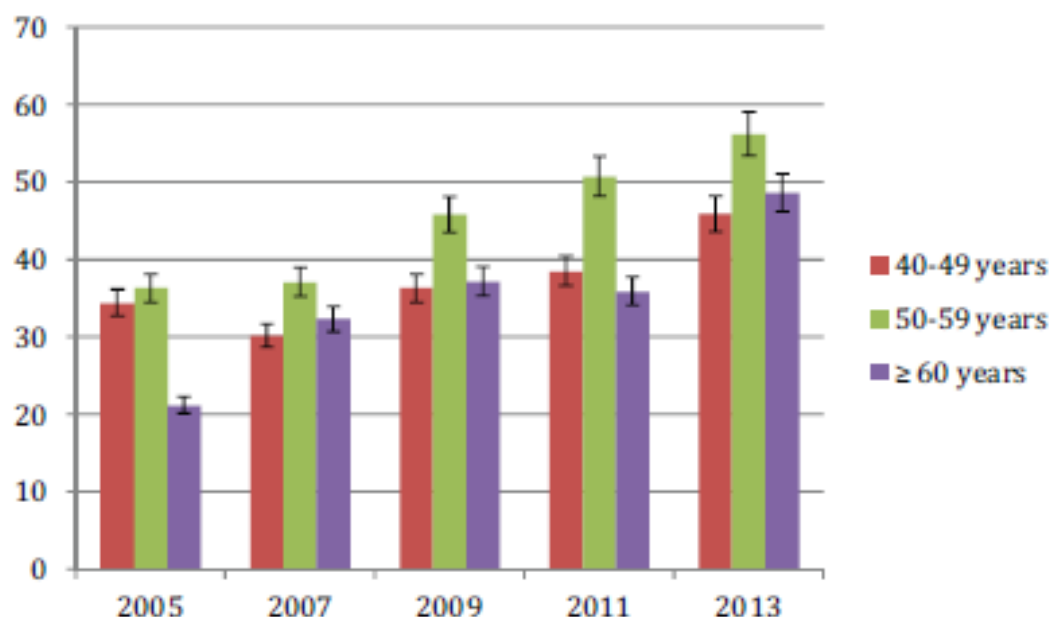


Figure 15. Ever-utilisation of screening mammography among women surveyed in Lebanon between 2005 and 2013. Uptake shown by age group. Source taken from (123).

An Italian study found that 57.4% of the younger sample attended mammography every two years (as recommended by Italian guidelines) compared with only 38.1% of those aged between 65 and 69 years (124).

Lower educational background is also associated with lower uptake (117, 122, 124-127). A meta-analysis of thirteen studies found the odds of attending were 61% higher among women with higher levels of education than those with lower levels, OR 1.61 (1.36-1.91), $p < 0.0001$ (127). In Brazil, illiteracy is associated with lower uptake; women who are illiterate have an RR for attendance of 0.77 (0.67, 0.90) compared with women who were literate (126). This shows that the phenomenon appears to be operating across more than one culture or country.

Aro *et al.* reported odds of attending that were 91% higher for Finnish women with a spouse compared with those without, OR 1.91 (1.51, 2.40), $p < 0.001$ (125). This sample was and similar to the Swedish study discussed below which found similar results but only had 50% response rate which could indicate an issue with generalisability. A secondary data analysis in Sweden found that when compared with women who were married or cohabiting, the odds of not attending BCS were significantly higher in women who were single/divorced/separated, OR 2.14 (1.56,

2.94) (128). This association between marital status and BCS attendance appears consistent worldwide and across study types (116, 123, 129).

The data for uptake in women with high incomes is difficult to ascertain. If these women attend, they are more likely to attend privately either by paying directly or through insurance policies which means that the data are not so well recorded as part of national or state systems (125). A large study in Australia concluded that late or lapsed attendance in the national programme was associated with health insurance coverage and higher income (130). It is difficult to ascertain whether those women did or did not attend privately as the data are sporadic. In general, and after consideration of private screening attendance, studies concluded that those with lower income attend screening less (122, 131). If the lower income women do not attend the national programme, it is unlikely they would obtain screening elsewhere. This lower attendance could be linked to societal influencing factors such as access and logistical means of attendance which I discuss in a later section. However, in Switzerland the socioeconomic inequality of mammography practice in agreement with recommendations has lessened. The difference between highest and lowest income groups here has reduced from 27 percentage points in 1998 to 14 points in 2012 (132).

In countries where the screening programme incurs out-of-pocket expenses, those with more disposable income will be more able to attend. In other situations, affluent women with insurance policies will have BCS access, whereas women with lower incomes or from more disadvantaged backgrounds will not be covered by insurance for BCS and will be less able to attend.

Many authors report that women who attend screening are likely to come from more affluent areas (79, 122, 133-135). Likewise, studies state that areas of material deprivation exhibit less participation (136). A study by Aarts *et al.* in The Netherlands found the odds of attending BCS were 50% higher in the intermediate SES group compared with the lower SES women, OR 1.5 (1.5, 1.6) and 80% higher in the higher SES group compared with the lower SES women, OR 1.8 (1.7, 1.8) (79). However, despite a longitudinal analysis of almost 20 years, the research was only conducted on one city which may not be generalisable to the whole country. However, it is

encouraging that the trends appear consistent across time periods, countries and types of analyses. A large Italian study of over 15,000 women reported odds of attending are 77% higher for women of intermediate SES compared with those of low SES, OR 1.77 (1.55, 2.03) (124).

In the UK low uptake rates have been observed among minority-ethnic women (122, 137). This could be attributed to language problems such as low levels of literacy or English fluency, cultural values and beliefs, lack of local access to services and/or poor attitudes of GPs as discussed in the literature (137-139). However, the disparity in uptake rates, particularly observed in the UK between Asians and non-Asians, is narrowing. In round one of the NHSBSP (1989-1992) uptake was 60.8% vs. 75.4% and in round five (2001-2004) uptake was 66.8 vs. 77.7% respectively (140). Despite this, figures remain low for Muslims (51% in rounds one and five) and other religious minorities (139). After adjustments for age and deprivation, uptake remains lower for all minority ethnic subgroups compared to White British women (140). In London specifically, attendance was lowest for Black women OR 0.47 (0.53-0.56) after adjustment for sociodemographics (135). In studies assessing the sole effect of ethnicity on behaviours such as uptake it is important, like conducted in this study, to have controlled for confounding factors such as socio-economic status and geographical variation. However, it does mean that the results of this study need consideration whether they are generalisable to the rest of the UK because of the specific nature of the analysis. Other evidence suggests foreign-born women (migrants) are less likely to attend national screening programmes in the UK (131) and so it appears appropriate to consider the results generalisable. Similar results have been shown in Sweden, Australia and in the United States (75, 141, 142).

1.3.3 Health status and history

The influence of family history of BC on mammography uptake is difficult to determine. In some women it deters attendance and in others it encourages uptake (119). Family history as a predictor must therefore be interlinked with other personality traits such as anxiety, perceived benefits or risks, current health status, and ability to access the programme.

Previous false positive results are frequently found to be predictors of lower reattendance (116, 138). However sometimes this difference can be minimal. In a database analysis of over 250,000 women from the UK national screening service, ninety-two percent (91.3%, 92.8%) of women with a previous false positive result attended subsequent screens versus 92.4% (92.3%, 92.5%) of those with a previous normal result (143). These results would be considered reliable as no self-report information was used, no study participation biases were introduced and a database analysis approach was adopted.

Rates of reattendance may also be determined by how invasive a re-test was. For instance, for reattendance in one study the odds of re-attending were 60% lower for women with an open biopsy (+/- needle sampling) compared with women with a previous normal screening examination, OR 0.40 (0.25, 0.66), $p < 0.001$ (143). In addition the odds for reattendance were lower in all other types of re-testing compared with women with previous normal results, for women who had had a needle sample only was OR 0.88 (0.84, 0.92), $p < 0.001$, women with no tissue sampling had an OR for reattendance of OR 0.99 (0.98, 0.99), $p < 0.001$ compared to women with a previous normal result (143). This suggests a dose-response deterrent effect may be involved.

Women with a good current state of health are more likely to attend BCS than those reporting poor health (77, 144). A Finnish study of almost a 1,000 women found odds of attending BCS were 31% lower in women reporting serious illness compared with women with no serious illness, OR 0.69 (0.54, 0.89) $p < 0.01$ (125). A meta-analysis, with no geographical restriction, supports this finding as it reported 46% reduced odds of screening in those with serious mental illness compared with women reporting no mental illness, OR 0.54 (0.45, 0.65), $p < 0.05$ (145). This occurred despite increased cancer mortality in this vulnerable population (145-147).

Nevertheless, a study among older women has found that SES and general health factors predict attendance at BCS better than physical and mental health or attitudes to health does (148).

1.3.4 Health service use

The healthiest women in the population have been found to be those who tend to have a high motivation for health and who are therefore often the attenders at BCS (77). Generally, mammography attenders have been found to be women who take more conscious care of all aspects of their health in their lives and who commonly value health highly. Correspondingly, these women are more likely to have attended regularly for their cervical screening as well as other healthcare appointments (77, 122, 149).

Women with a current prescription for hormone replacement therapy (HRT) have also been found to be more likely to attend BCS (133), as have women who practice regular breast self-examination (BSE) (77, 125).

Previous attendance at BCS is a strongly associated determinant of future attendance. One paper found the odds for re-attendance was significantly higher in women who had previous attended compared with non-attenders OR 8.17 (4.06, 20.09), $p < 0.001$ compared to non-attenders (117, 150).

1.3.5 Beliefs, attitudes and knowledge

Self-efficacy and personal confidence are associated with whether a woman attends BCS or not. Women who report higher self-esteem often have higher rates of screening (77). Those with low self-esteem may believe health behaviours such as screening for future health benefit is less meaningful or valuable and therefore are unlikely to participate (77, 122). Those who feel in control of their health are likely to attend health services more frequently (122, 151).

Risk of BC appears to have opposing effects on different women. Some research says attenders are more likely to feel at risk and feel vulnerable about developing BC (77, 144). However, in 1996, Drossaert *et al.* found that women with a higher perceived risk of BC were less likely to attend screening (152). This research highlights the influencing factor of 'perceived threat' in the screening decision, as incorporated within the HBM (112).

There are many psychological factors that influence a decision. Research has found that women who exhibit worry about BCS are less likely to attend screening (153) as are those who consider BCS embarrassing (154). Similarly, fear is found to be a prohibitive emotion to obtaining preventative healthcare such as BCS (137, 155).

For many women, reassurance is an appealing reason to attend BCS (154). However, this is not actually a true representation of what BCS can offer. A negative result is only an accurate result for that snap-shot in time and even then it may miss a small tumour. Nevertheless, women who want the reassurance about their BC status are more likely to attend screening (154).

For some women the decision whether to attend is a balance between cost and benefit. Attenders believe benefits of BCS must outweigh costs of attending (77). Despite knowledge of BC and the risks involved, women frequently underestimate their own personal risk (155). An optimism bias occurs with a common misconception that 'it will not happen to me' and the belief that there is no need to attend health checks. On the other hand, for women with other and additional health concerns, the benefit of BCS becomes smaller and they are therefore less likely to attend (156).

Women who anticipated pain from mammography were found to be less likely to attend (115, 154). However, pain is difficult to measure and study as it is largely subjective. The same painful stimuli may influence a woman's future decision to attend BCS differently (98). This adds to the complexity of the pain and discomfort phenomenon. A New Zealand study found that 46% women who declined reattendance cited pain as their reason (98).

A study in The Netherlands found that women who attend but then stop participating tend to have lower intention, perceive more costs, perceive a lower level of control, and expect more difficulties with BCS (157). Mammography attenders appear to have more knowledge about BC, including information about risk factors and the mammography procedure, compared to non-attenders (138, 158, 159).

1.3.6 Intention

Unsurprisingly, intention to be screened is one of the biggest predictors of actual attendance within BCS programme (77, 117). A prospective study of attendance in

inner London found higher odds of attendance for women who gave a “yes, definitely” response to their intention to attend versus those who did not, OR 6.19 (3.07, 12.50), $p < 0.001$ (154).

Whether women perceived screening to be important was found to be one of the two best predictors of uptake in London by Sutton *et al.* (154). This gives supporting evidence that the decision to attend screening can be influenced by educational information such as that provided by a leaflet.

Despite good intentions, a lack of alternative family care plans may also prevent a woman attending. For example, if a woman has child-minding issues she may not feel physically able to attend a healthcare appointment for herself. Other factors that influence uptake at an individual level may include simply forgetting to attend the appointment. Intervention trials have shown simple reminders improve uptake (160). A study in America showed that compared to controls, those enrolled in a telephone reminder service were more likely to be re-screened at the next round, with 35% compared to 24% uptake (161). Another American research team added that for women receiving a postal reminder, the uptake rate was 68.1% compared to those receiving an email reminder who had an uptake rate of 72.2%. The odds of attending BCS were 49% higher for women who received a reminder versus those without, OR 1.49 (1.35, 1.65), $p < 0.01$ (162). However, these techniques often rely on up-to-date mobile numbers or email addresses which are often not available for the entire population.

1.3.7 Accessibility and logistics

Distance to the breast screening centre is a known factor influencing the uptake of BCS with those who must travel further often having lower uptake (163). A deterrent for many women is not having a mode of transport with which to access the screening centre (138).

Factors that influence attendance at an area-level include migration. Regions with more transient populations exhibit lower rates of screening (136). This could be due to administration error or inaccuracy of the screening registers (139). For instance in areas that have a high turnover of population, women do not always register for GP

practices or may have left their registered address (154) and therefore some women do not receive their invitation.

Misinformation contributes to some lack of attendance at screening. A common reason stated by women for non-participation is that they were not informed by their healthcare provider of the opportunity for BCS (155). Further to this, the impact of illiteracy on uptake and understanding is of concern. If women do not understand the literature or guidance they will not be able to make IC about their screening participation (164).

1.3.8 Societal Factors

Non-attendance is linked to social isolation implying social support might be important for uptake of BCS (151). Compared with non-attenders, participants of BCS in the UK are more likely to report at least one close friend and/or know women who have participated (117). Likewise, those who have been recommended to attend by a friend or family member have been found to be more likely to attend than those without any such recommendation (77, 138). Women who lack social participation have a higher likelihood of non-attendance with OR of 1.21 (1.10-1.31) (151). Nevertheless, the association between social support and attendance is not always found to be consistent which may be due to reliance on self-report data (77). Social support via the marital bond is linked to higher attendance as attendance is higher in women with a spousal partner (115, 117).

Furthermore, some cultures and traditions prevent or prohibit behaviours that are conducive to screening uptake. For example, exposing oneself to a person other than a husband is forbidden, speaking about cancer can be a taboo, and cultural norms are somewhat prohibitive of BCS for some women (138).

Media can heavily influence a decision about health, either purposefully or unknowingly. This is demonstrated following a celebrity diagnosis or death (165). However, a less 'popular' public coverage, such as the publication of a report like the Marmot Review (96) has less clear impact on preventative uptake (166).

1.3.9 Summary of factors believed to influence uptake

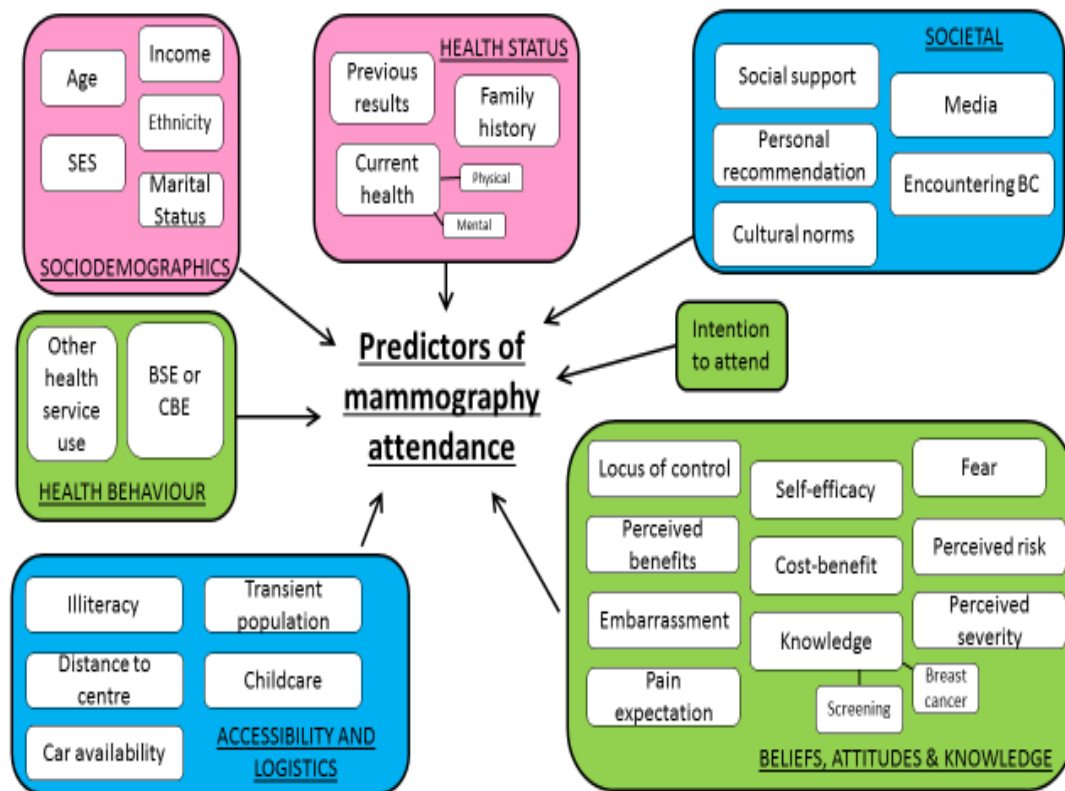


Figure 16. Summary of predictors of uptake at screening from the literature. Those highlighted in pink represent non-modifiable factors, green represents those that are modifiable and blue those that are external and situational but act at the individual level. CBE, clinical breast examination.

A woman's sociodemographic factors appear to influence the likelihood of her participating in BCS. Being married (122, 125, 126) and having a higher income (125, 130) are associated with higher attendance, as is higher literacy levels (126) and better social support mechanisms (151). Increasing age (118, 123), lower SES (79), lower education (124, 127) and being of a minority ethnicity (122, 137, 139, 140) are all associated with lower attendance. Women of some cultures and traditions have more restrictions on breast screening and have lower uptake (138) as do women who live further from the screening centre due to accessibility and logistical issues (163). Areas of transient populations also show lower uptake rates (136).

The influence of health status on breast screening uptake depends on the individual as each person reacts to stressors differently (119). Previous false positive results appear to reduce reattendance (116, 138), which could be dependent on how invasive the test is (143). Women attending breast screening seem to have a good

current state of health (77, 144). Women taking HRT are more likely to attend screening (133). Those attending screening are the more health-aware women in the population (117, 150).

Beliefs, attitudes and knowledge about screening are important too. Women who are self-efficacious tend to attend mammography more frequently (77) as do women who desire reassurance (154). Perceived risk has differing effects on women depending how they react to such stresses (152). Women who are worried (153), anticipate pain (115, 154), fear the mammogram process itself (155) or are embarrassed (154) are less likely to attend. Women must weigh up the benefits versus limitations in their cost-benefit analysis whilst making their decision whether to attend screening or not (77).

The biggest predictor of uptake is previous attendance at screening. Those who practice BSE are more likely to attend (77, 125). Intention to attend is another key predictor of uptake (77, 117). Women who perceive screening as important often participate more than those who do not believe screening to be important (154). Media can subtly or purposefully influence the uptake of screening quite dramatically (165).

These influencing factors of uptake interact with each other and are dependent on multiple other unknown factors. At the very least, they could look to influence uptake as shown in Figure 16. It has been shown that uptake is inequitable and education of women in a personalised approach would likely enhance the making of an IC in BCS decision making.

1.4 Patterns of Attendance

There are natural patterns and fluctuations in women's attendance at BCS which is likely to be because mammography is not a compulsory requirement for healthcare provision in the UK. There are four attendance patterns in health screening – "consistent" (a woman who regularly attends appointments each three years), "dropout" (used to attend regularly but has stopped), "delayed" (used to miss appointments but is now participating in mammography) and "refused non-attenders" (never been screened) (167-169).

The study by Drossaert *et al.* (157) found four differences between consistent and dropout attendees. This is consistent with the TPB as proposed by Ajzen in 1991 (108). The four variables are that women who dropout had a lower level of perceived control, had lower intention to attend screening, perceived more costs involved and expected more difficulties when compared with women who attended consistently (157). Despite high attendance rates at first invitation, participation rates appear to decline with each round of invitation (117).

Furthermore, there is a group of women who are termed “intermittent attenders”. These women occasionally miss screening rounds and attend appointments infrequently. They are not similar in socio-demographic profile to “refused non-attenders” and should not be considered in the same way (168). Intermittent attenders represent around 15% of those invited and are a distinct subgroup from attenders and non-attenders (114).

The national dataset “KC62” is provided by the Breast Screening Programme to the Health & Social Care Information Centre (HSCIC) and shows a possible change over time in attendance at BCS. The Forrest Report, written in 1986, resulted in the setting up of the breast screening programme with the first women being screened in 1987. A sudden rise seen in 1994 (Figure 17) could be attributed to the initiation of the NHSBSP. However, it was only by 1994-95 that most screening units had completed the ‘prevalent’ round (66). It is therefore considered that the graph should be viewed as starting from the highest point, at 1994-1995, to minimise the influence of the rolling-out phase of NHSBSP. The graph shows the uptake has changed over the last decade from 75.2% to 72.1% in 2013-2014.

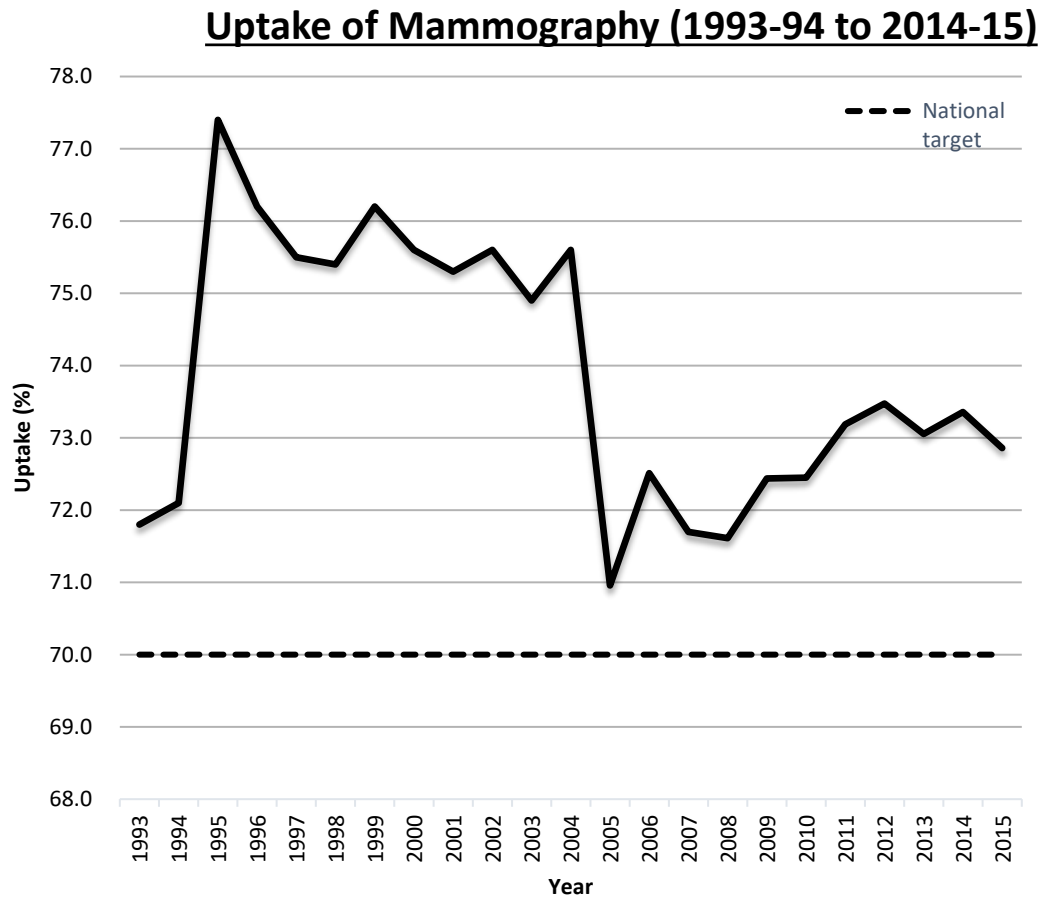


Figure 17. Uptake of breast cancer screening by women aged 50-70 in England, 1993-94 to 2014-15. Data taken from KC62 available as report (6) on HSCIC website [<http://www.hscic.gov.uk>]. *Data excludes short term recalls, self/GP referrals and those included within the age extension trial.*

The national minimum uptake standard is 70% with a target of 80% set for cost-effectiveness and population benefit (69). There is cause for concern regarding this changing uptake as its decline approaches the minimum required (70%). If attendance drops below this level it may affect whether the programme is considered cost-effective for the NHS (6). Data for the previous ten years is provided in Figure 18 which shows a small increase in percent attendance in the 2015-16 cohort (170).

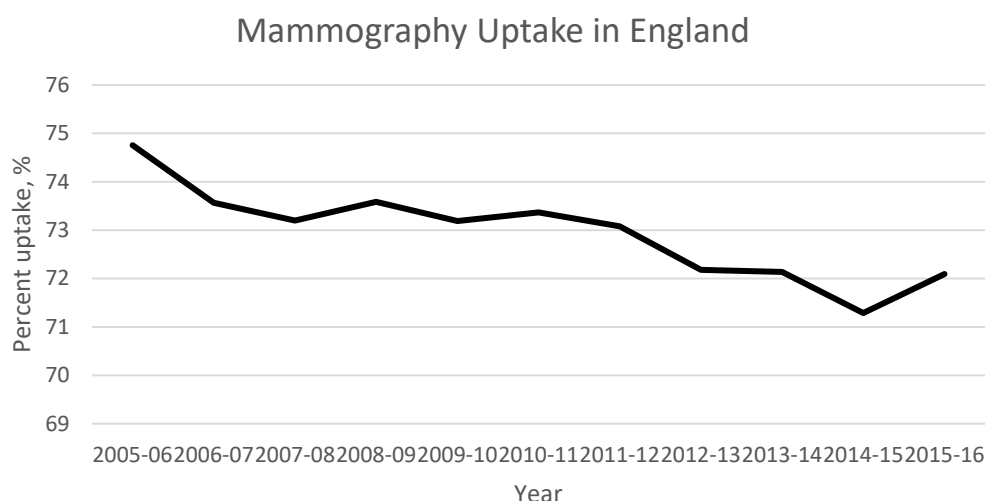


Figure 18. Uptake by women aged 50-70 to invitations for breast screening in England between 2005 and 2016. Data taken from (170).

According to data from the national KC62 dataset, there was a change in the number of women attending for screening in 2005 as shown in women attending although, admittedly, this can be difficult to see amidst the fluctuating trend line.

There are several explanations for a possible change. For example, the introduction of a new administration system for booking appointments may mean that fewer women received the correct appointment invitation. Or perhaps there were fewer public advertisements about the benefits of screening and perhaps contrariwise more media attention was paid to the negative components of screening.

It is not currently known in whom the changes in attendance patterns are occurring. The second study of this research project addresses this literature gap by providing evidence using London data. If there is a change in uptake behaviours among the screening population of London it is important to understand in which women this change occurred (96). Following this research, a wider sample will be needed to confirm generalisability across the UK.

In the UK previous results show attendees are more likely to be younger, married, middle class (171) and reside in urban areas (115). This is consistent with profile predictions conducted by Canlan *et al.* of non-attenders being single or widowed and aged over 60 (77). Socially disadvantaged women are less likely to attend the first

round when invited and are more likely not to attend further screening rounds (114). Further, there is geographical variation in uptake over the UK (shown below in Figure 19) which could be attributed to regional poor access or differences in socio-demographic profiles.

Regardless, it is important for the NHSBSP to determine if geographical location has an influence on screening uptake. Fifteen Breast Screening Units (BSUs) currently fail to meet the 70% national target for uptake and 29 BSUs are within 5% of the target (66).

It is vitally important to know in whom the uptake patterns are changing. Is it the older women who are now not participating, or is it a cultural phenomenon prohibiting uptake within one ethnic minority? Understanding which women may or may not have changed their attendance preferences may highlight important inequalities within the screening programme which we can then aim to address. Secondary data analysis will be able to answer the question of who participates for women in London, from which further research will be warranted.

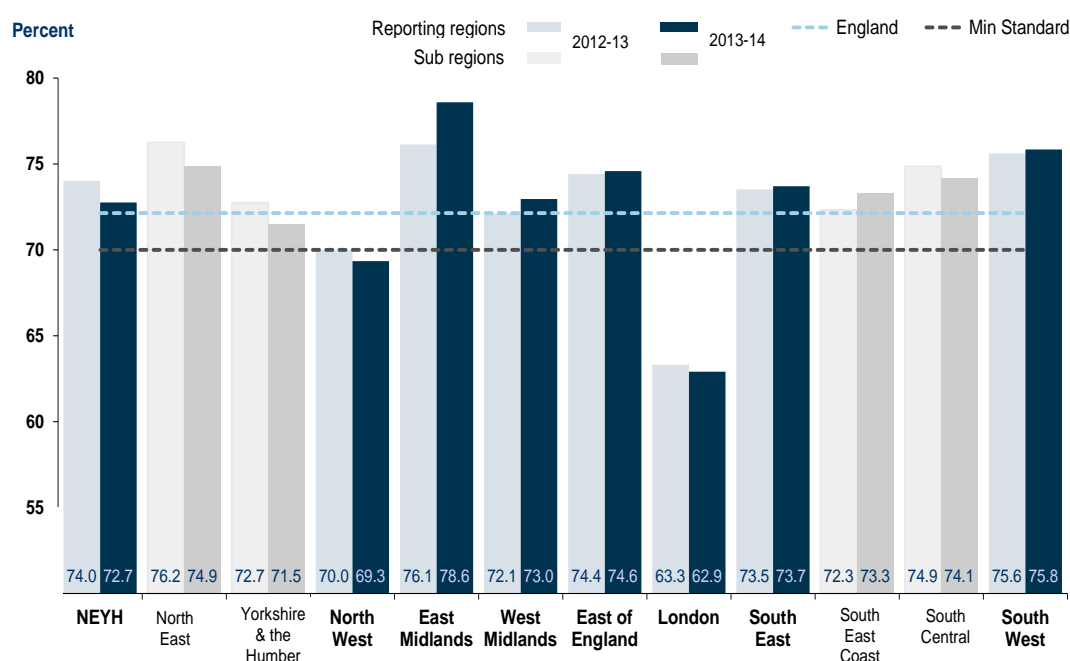


Figure 19. Uptake* by women aged 50-70 of invitations to screen by reporting region. England, 2012-13 and 2013-14. *Data excludes short term recalls, self/GP referrals and those included within the age extension trial. Graph sourced from KC62 and HSCIC Report (66).

1.5 Informed Choice (IC)

An IC is classified in this research using Marteau *et al.* (2001) definition as a '*decision where all available information about the health alternatives is weighed up and used to inform the final decision; the resulting choice should be consistent with the individual's values and is actively implemented by the person's behaviours*' (164). Based on this, there are three components (knowledge, attitude and uptake) that allow two combinations that can be classified as an IC, graphically represented as boxes one and four as shown in Figure 20 below. A woman must have sufficient knowledge about the consequences of a positive result, the probability of a false positive or negative result, and the uncertainty about the screening test etc. as identified by the General Medical Council as prerequisites for making an IC. These components should be included within the knowledge questionnaire as part of the IC model (172). In addition a woman will either have a positive or negative attitude towards mammography and these attitudes need to reflect her attendance. For example, a woman with sufficient knowledge and a positive attitude to screening must attend screening to have made an IC (box one). Similarly, a woman with appropriate knowledge may have a negative attitude to screening and therefore in order to make an IC she must not attend screening (box four).

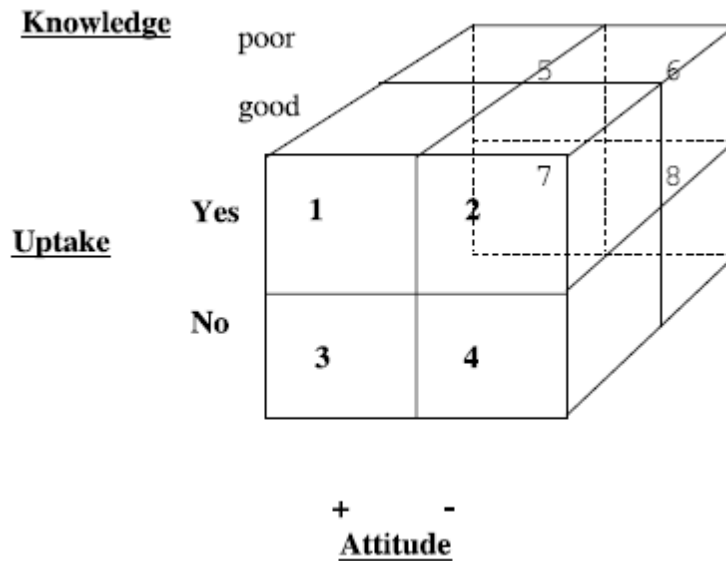


Figure 20. Classifying informed choices based on knowledge, attitudes and behaviour (164). Boxes '1' and '4' represent informed choices.

With Marteau's definition of IC stated above (164), women are not provided sufficient information to make an informed decision without researching further information themselves (60). The Patients' Charter (173), subsequently replaced by an updated 'NHS Constitution for England in 2012' (174), states that individuals must be told if a treatment or investigation has the potential to result in serious adverse outcomes, and be told its alternatives, before they agree to participate. Gotzsche *et al.* criticises the 'Helping you Decide' breast screening leaflet for its 'lack of balanced information, omission of harms and limitations of screening and exaggerated estimations of benefit' (60, 61).

The UK breast screening leaflet

The breast screening information leaflet is the key information source provided to all women to help them make a decision about attending screening (175).

The Independent Breast Screening Review panel recommends that clear information should be given to women invited to screening (176). The then current leaflet went through vast redesign including advice from women and input from professional experts in public engagement, IC and communicating risk. The draft leaflet was then

cognitively tested with women before integrating all advice and a final check from the advisory committee (176).

Despite this, the updated leaflet is still heavily criticised for not giving enough information to make an IC (59-61, 177). The NHSBSP information leaflet has been critiqued by Gotzsche *et al.* as being 'not necessarily easy-to-interpret and can be misleading' (60). It has been argued that the current leaflet is confusing and provides insufficient information to allow women to make an IC about attending BCS (61). The NHS BCS leaflet is considered by some not to contain enough information regarding the decision to participate in screening (94, 178).

A random sample questionnaire study in Oxfordshire was therefore conducted to test the levels of knowledge before and after the new leaflet (179). This study found that although numerical comprehension of lifetime risk of BC and purpose of screening had improved the qualitative interpretation of this risk varied. Additionally, some simple messages such as screening does not prevent cancer had not been understood by all (179). However, it was only a small sample of women (n=100) in one area of the UK and therefore it cannot be assumed that the results are generalisable. More research is needed.

The leaflet often concentrates on the benefits of screening 'the NHS offers screening to save lives from breast cancer' (63) and it tends to minimise harms or limitations of the process 'screening does have some risks' (180). Despite undergoing rigorous evaluation and expensive renovation, the leaflet still comes under intense scrutiny and criticism (61, 63). The leaflet briefly mentions a harm 'some women find mammography uncomfortable or painful', but in fact this is a widely reported phenomenon and a significant deterrent of further mammography uptake so deserves more focus than a brief harm (60, 181).

Furthermore, the balance and measurement of benefits and harms is a personal judgement and decision, and their distinct impact will be understood differently for each woman. It is not clear from literature if the benefits of screening outweigh the harms at a population or individual level (94, 96). Mammography trials have shown a reduction in BC mortality but have also shown significant overdiagnosis (87, 96).

Technology and treatment options have changed since the trials and the effect this has had on the balance of benefits and harms of screening is not known (60, 61, 96). These uncertainties are not discussed in the leaflet (63).

IC is recognised as an important component of personal autonomy and is common practice of good medical practice ethics (172, 180, 182, 183). Reflecting this, policy has recently changed and the NSC now recognises the responsibility of screeners to ensure patients are fully informed and are making a decision that is right for the individual (102, 172, 183-185). Policies advise that potential adverse effects should be made explicit to potential participants (186). Michie *et al.* (186) suggests that whilst knowledge may not influence a woman's decision to attend screening, it may influence their understanding and reaction to their test results.

Those who make an IC make value judgements including complex trade-offs between potential benefits and harms of BCS. It seems likely that there is a relatively unspoken fear held by policy makers that unbiased, clear information may deter people from participating in screening programmes (187). The effect of IC on uptake of BCS is so far unconfirmed.

It is not known yet what influence making an IC may have on breast screening uptake in the UK. The literature is not consistent, with evidence for both increased and decreased uptake rates as a consequence of more IC (102, 174, 183, 185). Accessing information relevant to health decisions has become increasingly important as women attempt to make informed decisions in BC screening (102).

Key performance indicators, used as programme targets within the NHSBSP, currently rely on uptake rate. This assumes that participation is equivalent to an informed decision. Many women trust the healthcare service and welfare state and since they are provided with a pre-scheduled appointment they may assume this is the 'correct' or 'best' decision. This process highlights why attendance at the BCS appointment cannot be used to determine whether an IC has been made or not. A proper, formal, assessment of a woman's knowledge and attitudes is required to evaluate whether they have made an IC.

In Australia, a patient decision aid was trialled for use in the bowel screening programme in 2008 (188). Participants in the intervention group were given a decision aid which comprised an interactive question list and a DVD explaining risk and possible outcomes compared with no screening. The control group received standard information leaflets. Results suggest those who received the decision aid displayed higher knowledge than the controls and less positive attitudes towards screening. Participation was lower in the intervention group, with 59% completing the faecal occult blood testing compared with 75% of the control group (188). For Australia's bowel screening programme at least, tailored decision aids support making ICs but this may come at the expense of uptake. It is not unrealistic to expect similar results in the UK within the breast screening programme, as hinted in Germany which is discussed below.

Regardless of its positive or negative influence on uptake, IC is becoming more commonly considered in cancer screening programmes. The German health system is starting to change and is moving towards informed citizens rather than aiming for the highest participation, even at the expense of uptake. IC will be a key indicator of quality for their programme (62, 102, 189, 190).

The factors affecting an IC to attend screening are not known and may depend on personal risk of BC or socio-demographic characteristics. Decisions are based on many different factors and are complex. It is assumed that women use both intuitive, instinctive reactions along with logical reasoning, scientific deliberation and analysis to make a decision in health (191).

The patient information leaflet given to women is considered by some to be biased towards screening and insufficient to make an informed decision (184). Even if it was clearly explained in detail, it cannot be guaranteed that women will incorporate more balanced and detailed information into their decision-making process (186). This is particularly true as the benefits of screening are often many years delayed and relatively uncommon whilst harms are often misunderstood and viewed with minimal concern (192).

Balanced sources of information are ethically important in healthcare. However simply providing factual information may not substantially increase the proportion of women making an IC. Women may not read the leaflet or they may not understand what they read (193). The Fuzzy Trace Theory distinguishes between two types of understanding, 'gist' and 'verbatim', in screening information. The theory suggests that many people rely on the gist of whether a risk is increased or decreased to make their decision (194), therefore more specific information may not be useful (195).

People who are lower in numeracy capabilities may find it difficult to establish their personal risk (187). The 'Computational Approach' describes a psychological mechanism of personal numeracy, emphasising that poor decision making may be the 'result of information overload and failure to sufficiently process information', which subsequently produces an uninformed choice due to insufficient knowledge (194).

People with lower numeracy may be more likely to overestimate their own personal risk of BC, and more likely to overestimate the benefits of screening (196). If it was to be introduced, knowledge testing for IC should therefore include both specific and general screening questions as well as BC risk knowledge.

1.6 How to achieve an IC

For the NHSBSP, achieving an IC is more complicated than simply providing women with all the information. Including all information about false positives, overdiagnosis, and the full screening procedure would fulfil GMC guidance about informed consent (102) and respect individual independence but could be overwhelming for women and contain too much detail to allow for extracting the relevant and important information.

Supplying information as a leaflet is low cost as it is simply providing printed information with minimal staff time needed. However simple distribution of leaflets does not provide sufficient opportunity for an IC to be made (102). Using IC as a programme quality indicator would likely increase the amount of time required by each staff member to explain and ensure that women are fully informed, at increased expense for the NHS.

It is understood that for women to make their own informed decision they need sufficient information (164, 186). Despite recommendations for increasing IC (134), being open with women about the pros and cons of screening could risk a reduction in uptake for the NHSBSP (102). A minimum uptake rate (currently 70% in the UK) is required for the NHSBSP to be cost-effective and viable.

Whilst providing biased or incomplete information focused on the benefits of screening may help achieve maximum participation, it does not help achieve maximum informed participation (102).

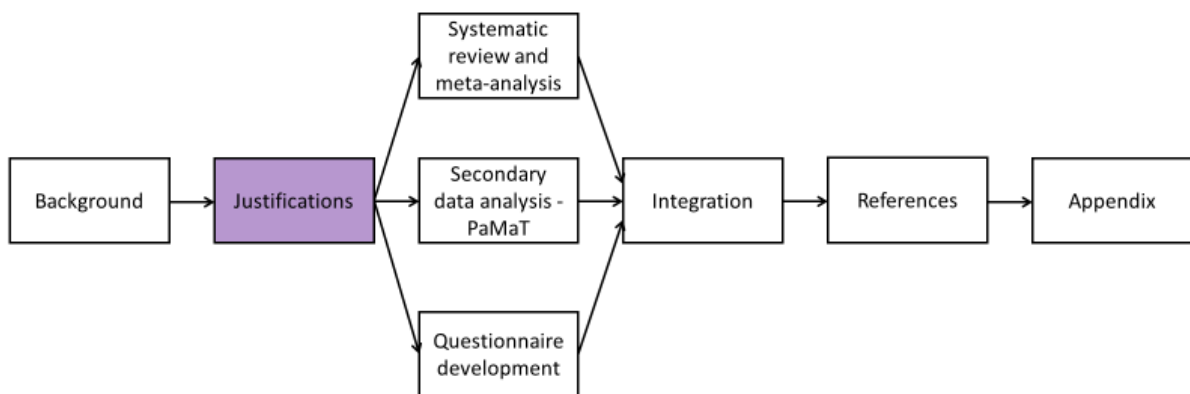
Chapter Summary

This chapter discussed the epidemiology of BC and risk factors predisposing women to the disease. It explained the basics of screening with a particular focus on mammography and debated its advantages and limitations.

Uptake of screening is dependent on a complicated network of factors and influences that have been discussed with different attendance patterns highlighted in different subgroups of the population. This is investigated further in later chapters such as the systematic review and the secondary data analysis.

As the NHS moves away from a paternalistic approach in medicine, ensuring women make an IC is becoming more important. For an IC to be made, knowledge and attitude need to reflect behaviour. Attendance at the appointment cannot therefore be a representation of IC. When providing women with transparent information to increase knowledge mobilisation a more personalised approach will be necessary to ensure each woman is making an IC consistent with her own values. More research into IC is described in Chapter Seven during the questionnaire development study.

Inequalities exist throughout the NHS and are no doubt present in the NHSBSP in respect of who attends screening and who makes an IC. It is vitally important to ascertain in which women patterns of attendance at mammography is changing. From there, research can be conducted about why it is happening and whether anything can be done to reduce the inequalities.



Chapter 2: Justifications

Introduction

In this chapter I describe the gap that my research aims to fill and discuss the importance of my research to this field. Firstly I explain the overarching thesis research problem and how my work will contribute. I then explain how each of my studies will combine to fill the research gap.

This chapter also describes and justifies the study designs and methodological tools used to answer each research objective. Strengths and limitations of the chosen methods and approaches used are discussed to determine the appropriateness of the findings to answer the objectives.

2.1 Research questions for thesis

This PhD has been funded by Collaboration for Leadership in Applied Health Research and Care West Midlands (CLAHRC-WM) as part of the NIHR doctoral scheme. After significant reading and searching within the literature I identified an important literature gap in the field of patterns of mammography attendance and IC within uptake. This project contributes to the existing literature and answers some of the unanswered questions in the field surrounding changing patterns of attendance.

In the previous chapter I highlighted how various predictors of uptake are interlinked and create a complicated network of influencing factors. I hypothesised that patterns of uptake are changing and potentially declining (197). Regardless of any change, it is unknown in whom this is occurring. It is vitally important to know this because understanding the changes in patterns of attendance will highlight potential inequalities in the NHSBSP and consequently have valuable implications for planning of services.

There are clear research gaps in this field which are stated below. There has not been a recent global overview of predictors of BCS uptake. Most studies focus on single predictors of uptake and this research needs updating. Globally, each country has a different screening programme and therefore diverse categories of predictors of uptake. For instance, the screening programme in the USA relies heavily on

insurance. Having insurance and the type of insurance held is much more important as a predictor of uptake in the USA compared with the UK where mammography is provided free at the point of care. In the UK, it is more likely to be factors such as age, ethnicity and other health issues which predict whether or not a woman will attend breast screening.

It is unknown whether patterns of mammography attendance are changing over time and if so, in whom. Recent data shows a 1% decline in uptake of BCS in the last year (197). Furthermore, there are clear literature gaps in understanding what influence making an IC has on uptake. It is also unknown if making an IC is dependent on personal characteristics of women. In the UK we do not know and cannot identify which women make an IC in BCS.

The research questions, and consequently studies, aim to fill these gaps. The research questions of this thesis are:

1. What are the predictors of BCS uptake worldwide?
2. What are the predictors of BCS uptake in the London, UK population?
3. Are patterns of BCS attendance changing in the London, UK population?
4. In whom are patterns of attendance changing in the London, UK population?
5. What questions can be asked to explore whether personal characteristics and/or personal BC risk, influence making an IC?

2.2 Rationale, research gap and justification

From a scoping literature review and background reading it appears that breast cancer screening uptake is changing. The underlying reasons for changes in BCS uptake are not clear.

To date, research has often focussed on particular sub-groups of the population. Previous studies have examined a small number of predictors for either attendance or non-attendance. In 2008 a large systematic review was conducted in America that sought to summarise the available literature regarding factors associated with mammography uptake (198). However, this 2008 review included self-report data, only analysed data from the United States and was conducted ten years ago. Self-

reported data is consistently villainised for its unreliability in the accurate reporting of health behaviours and involves a threat to the validity of the data which weakens any inferences or results made from the data (199). This particularly seems true when the behaviour under question could be considered by the public as undesirable or if the individual is trying to avoid feeling judged for their behaviour (200, 201). The systematic review conducted for this research will be a more robust analysis as it does not include self-report data, it will be a more inclusive review as it is not restricted geographically and it will be an updated review.

In the UK, the NHSBSP is tightly regulated to adhere to guidelines and standardised outcomes. The screening programmes must report data annually on key performance indicators. A performance threshold is set for 70% of the population to be screened as a minimum and the achievable level is set at 80% (202). Guidelines state this percentage of uptake should be of all eligible women who wish to participate (203). However, the review has shown that ethnicity, morbidity, education and income are predictors of uptake and therefore this may be disrupting accessibility and equity of the screening service.

Therefore it is extremely important to determine which factors are of most importance in determining uptake and reflect on how these are influencing participation in the UK.

In London, it is unknown if patterns of attendance at BCS are changing. Although the change is unidentified currently, it is hypothesised to be decreasing in certain sub-groups of the population and not in others.

One of the public health aims of screening programmes is to ensure access for all by providing an equitable service. Provision of clearer information may lead to greater inequalities in who decides to attend BCS and who makes an IC about attendance. It is possible that the 'highest risk, concurrently hardest to reach groups may be the most easily deterred' (190). It is therefore imperative to identify in which sub-groups uptake is changing to determine the effect this may have on BC rates and long-term mortality. Moreover, it is also important to recognise any such changes to minimise widening health inequalities.

Meanwhile, it is also hypothesised that it is not just demographics that influence uptake of BCS. Personal characteristics, women's own personal BC risk and perhaps whether they are making IC are all known to influence uptake as explored above. The third study will develop a questionnaire that can be used to investigate how these factors are associated with BCS uptake in the UK.

The NHSBSP has two key aims, to reduce mortality and morbidity from BC. They aim to do this by ensuring as many women are screened as possible. In light of modern ethical responsibilities to provide patients with clear information to encourage women make an IC, there is concern about the incompatibility of these aims with the moral obligations.

To ensure an IC, women must be informed about both the benefits and harms of screening. Despite fears that clear information may deter women from participating in breast screening (187, 188) the effect on uptake rates is not yet known (102, 174, 183). If there is an association between making an IC and BCS uptake, it is important that research is conducted to identify which women this will likely effect.

In this thesis I will investigate predictors of uptake internationally, analyse patterns of attendance at a breast cancer screening centre in London, and develop a questionnaire to evaluate which women are making ICs and analyse if IC or their demographic predictors are influencing patterns of attendance.

2.3 Overall thesis aims and objectives

Overall, the aims of the thesis are:

- to identify the predictors of worldwide BCS uptake
- to recognise if patterns of attendance are changing and if so, in whom
- To explore women's views on the drafted questionnaire

The underlying aim of the research is to contribute new knowledge to the field. I will achieve my aims by completing the following objectives for the overall thesis.

Project 1: Conduct a systematic literature review of worldwide research to identify the global predictors of uptake of breast cancer screening.

- Analyse predictors of uptake using meta-analysis where appropriate

- Narratively synthesise data not suitable for meta-analysis
- Provide an overall summary of the findings of the systematic review

Project 2: Obtain South West (SW) London dataset with the relevant data on uptake of BCS to ascertain if patterns of attendance are changing and if so, in whom?

- Conduct analysis of this dataset to:
 - Identify predictors of uptake within the SW London screening centre
 - Analyse whether patterns of attendance have changed over time within SW London
 - Further analyse change in attendance over time within specific groups of women to identify predictors for any change

Project 3: Develop a questionnaire that can be used in the future to understand if personal characteristics or personal BC risk influences IC and/or breast screening uptake

- Work with patient and public involvement for the development of the questionnaire documentation
- Use cognitive interviewing to develop the questionnaire
- Adapt the questionnaire documentation as recommended by results of the research

A key part of this research will be to disseminate research results using publications and conferences where appropriate.

2.3.1 Hypothesis

There are many predictors that influence BCS attendance and this network of influencing factors is complicated. I predict that uptake of BCS has changed over time. I am expecting to find uptake of mammography to be lower in older women, in women with lower socioeconomic status and in ethnic-minority women. I anticipate

finding a complex phenomenon around the effect of false-positive results on subsequent uptake. I expect there to be an intriguing pattern of uptake in relation to IC. I predict that there will be a subgroup of women (who may be of higher SES) making more ICs about breast screening. I hypothesise that this will reduce their likely uptake of screening. This will be investigated in future research using the questionnaire tool developed as part of this thesis.

2.4 Methodology justification

2.4.1 Systematic Review

A systematic review is considered by many to be the gold standard approach to evidence synthesis (204). The expression '*systematic*' review underpins the entire method and approach used in order to increase reproducibility and reduce bias.

For the current review, a formal protocol was written using standardised methods for the search, evaluation and selection of primary studies enabling objectivity and methodological reproducibility (205). The protocol was uploaded to the PROSPERO website for full transparency, as encouraged by the creators of the database (206).

A broad search was conducted to ensure that all types of predictors of mammography uptake were identified. However, this review was undertaken to quantitatively evaluate the effect different predictors had on mammography uptake. Whilst qualitative studies would provide detailed exploration of why different factors influenced uptake and would be extremely useful for future research to establish, this was not the purpose of this review and as such they were excluded from the review using pre-established screening criteria.

Where data are unclear, an executive decision needed to be made about how to deal with the information. For this review, data were excluded from the analysis where it could not explicitly be determined which women participated or did not participate. Also, data which did not represent a screening population i.e. which investigated an entire sub-group (i.e. all attended) and presented percentages of which women were from which demographic were removed. This was stated prior to commencing the review using pre-specified inclusion and exclusion criteria (206).

My research had a six study overlap of included articles with the American review mentioned above. This justifies the purpose of conducting my systematic review on the topic.

A random effects model was chosen to allow for the possibility (and probable) that population parameters vary between studies. The assumption made in fixed effects models, that these parameters are identical across all studies included in the meta-analysis would be unrealistic and erroneous (207). Furthermore, where no covariates are obvious explanations of the heterogeneity observed in the data, random effects meta-analysis is the most appropriate method – some heterogeneity gets explained by the variables included in the model and the residual heterogeneity becomes modelled (208).

Where data were dichotomised into groups, data were examined using Mantel-Haenszel random effects meta-analysis and the effect is presented as an odds ratio (OR). Where data were provided in more than two discrete groups, sub-group random effects meta-analysis was conducted to compare overall proportion attendances. Random effects models were used to allow for differences in the underlying proportions of attendance between studies (209, 210).

2.4.1.2 Quality Assessment

One of the challenges of systematic reviews is that they rely on the quality of the included published research. Additionally, frequently there is no individual data provided and the research team have to rely that the summary statistics and data included in the studies are accurate and include few errors. To better understand the limitations of the available data, I conducted quality appraisal of all included studies.

In systematic reviews having a tool to appraise quality is a vital part of interpreting and synthesising the evidence. It is also a way of ensuring consistency and limiting researcher bias when assessing the included data. There are a variety of tools that can be used for this process, including the two described below.

The Quality Assessment Tool (QAT) is used to assess if a study was well conducted. This tool can be used for quality assessment (QA) on any quantitative study (211). It contains 6 domains: selection bias; study design; confounders; blinding; data

collection methods; and withdrawals and dropouts. It is based around the hierarchy of evidence used in evidence based practice and therefore tends to rate randomised controlled trials as higher quality than descriptive studies or case reports as discussed by Tomlin and Borgetto (212).

Quality in Prognostic Studies (QUIPs) is more focussed on whether the results of the study are realistic and believable. It is used only for QA of prognostic studies (213, 214). This tool also contains 6 domains considered important when evaluating bias in prognostic studies, including: participation; attrition; prognostic factor measurement; outcome factor measurement; confounding measurement; and statistical reporting and analysis.

The domains are very similar and match well as shown in Table 3. Many of the QA questions cover the same detail. However, the 'blinding' domain of QAT does not affect the overall category score and does not have an equivalent domain within the QUIPs and there are no prompt questions within the QUIPs tool for this.

Table 2. Quality assessment domain comparisons

QAT Domain	QUIPs Domain
Selection Bias Study Design	Study Participation
Withdrawals & Dropouts	Study Attrition
Confounders	Study Confounders
Blinding	(No matching domain)
Data Collection Method	Outcome Measurement Prognostic Factor Measurement
Analysis	Statistical Analysis and Reporting

One of the main practical differences between the two tools is how you complete them. Using the QAT, you either circle yes/no or the answer such as 'very likely' or 'somewhat likely'. From this, there are instructions on how to rate the section and this translates into an overall summary rating, either strong, moderate or weak study. Detailed instructions are given on how to rate each paper (211, 215).

In the QUIPs tool, each domain is split into multiple questions for which comments and/or evidence are required. Following this, the user provides a rating for each question and then offers an overall rating of bias either low, moderate or high. This method is, by its very nature, more subjective as there are no overarching guidelines for assessment and ratings. QUIPs prefers no overall global rating of risk of bias as recommendations have been made against a summary score of overall quality, (213), so the tool simply provides six ratings of bias.

Another key difference is the omission of blinding questions in the QUIPs tool. This is important for assessment of RCT studies in particular. Not blinding the researchers involved in the study could easily bias the trial analysis and results. This is a major limitation of the QUIPs tool.

A significant variation between the tools was the level of detail in the questions asked. For example QUIPs asks six questions for both outcome and prognostic factor measurement domains, whereas QAT only asks 'were data collection tools shown to be valid?' and 'were data collection tools shown to be reliable?' with simple yes/no/can't tell answer formats.

QAT uses questions within its assessment to create an objective measure which should remain consistent across time and researchers. Indeed, between the reviewers CN and RC there was only one discrepancy when using the tool and this was due to an initial misunderstanding of the tool's instructions. Comparatively, the QUIPs tool could be considered much more subjective, particularly as there are no rules or guidelines how to determine low, moderate or high risk of bias.

Armigo-Olivo *et al.* concludes there is no evaluation of 'reasons for missing data' or the 'handling of missing data' in the QAT (216). When they compared the QAT with the Cochrane Risk of Bias Tool assessment, they found that the QAT performed

better and had a 'fair' inter-rater agreement of 0.60, (presumably it was not high because of the level of subjectivity required to complete it) (216). In a study by Hayden *et al.* the QUIPS tool is found to have a moderate to substantial inter-rater reliability of 0.56-0.82 (median, 0.75) (213). However, this study had its own limitations such as only using an expert panel who may 'overestimate usability and reliability scores' (213).

To further explore the practical differences and some potential limitations of each tool, RC took three papers that were included in the final review as examples to compare the two tools (Ulcickas, 1999 (169), McCarty, 2003 (217), Zidar, 2015 (163)). The acceptability and comparability of both quality measures was compared, both tools scored identical ratings for withdrawals/study attrition (scored N/A) and data collection methods/PR and outcome measurement (scored low risk). The blinding domain was only available in QAT and QA about the analysis component of the study was only available in QUIPS due to the nature of the study and the QA questions asked. A difference was found in the study design/study participation domain, QUIPS scored one paper 'moderate' and the others 'low' whereas QAT scored them 'moderate' and 'high risk' respectively. Likewise in the confounding domain, QAT scored all papers 'low risk' whereas QUIPS scored each differently ('moderate', 'low' and 'high risk'). This is shown in Table 4 below.

Table 3. Comparison of the two tools using included papers of the systematic review: Ulcickas (169), McCarty (217) and Zidar (163). For QAT, scores equate to the following: low = low risk of bias, moderate = moderate risk of bias, high = high risk of bias, NA = not appropriate for this study. For QUIPs, scores equate to the following: 1 = low risk of bias, 2 = moderate risk of bias, 3 = high risk of bias, NA = not appropriate for this study.

Domain (QAT above QUIPs in table heading)	Study	QAT scores	QUIP scores
Selection Bias & Study Design Study Participation	McCarty, 2003 Ulcickas, 1999 Zidar, 2015	3 & 2 1 & 2 1 & 2	2 1 1
Withdrawals/Dropouts Study Attrition	McCarty, 2003 Ulcickas, 1999 Zidar, 2015	NA NA NA	NA NA NA
Confounders Study confounders	McCarty, 2003 Ulcickas, 1999 Zidar, 2015	1 1 1	2 1 3
Blinding (not on QUIPs)	McCarty, 2003 Ulcickas, 1999 Zidar, 2015	NA NA NA	-
Data Collection Methods Outcome/Prognostic factor measurement	McCarty, 2003 Ulcickas, 1999 Zidar, 2015	1 1 1	1 & 1 1 & 1 1 & 1
(Analysis) Statistical analysis and reporting	McCarty, 2003 Ulcickas, 1999 Zidar, 2015	-	3 1 1

RC and the second reviewer used the QAT tool to encourage consistency across all QA by using the same tool throughout the review. Although it is preferable to use the QAT with RCTs, the QAT tool can be used for all quantitative study types within all public health topic areas. This proved advantageous as this work incorporates data from a wide variety of studies and methodologies (211).

Meta-analysis has been conducted where three or more studies provide information to the identical predictor analyses. Odd ratio forest plots have been provided where

the data allowed and if not, sub-group analysis was conducted and proportions attending reported.

To effectively perform a multivariate meta-regression analysis, certain requirements must be met. This includes having at least ten studies reporting data on all (or most) of the predictor variables (218) and the pooled prevalence of screening attendance across all 91 studies must be objectively determined. Without the total number of attending and non-attending women reported in each study, irrespective of the predictor variables, the second requirement cannot be met. Whilst there are methods to be flexible about the first requirement, the second is fundamental because we cannot afford to ignore the substantial amount of missing data if the attendance was simply pooled based on the predictor category with the largest number of attenders. Therefore meta-regression was not conducted.

2.4.2 Secondary data analysis

There are many advantages for conducting a secondary data analysis for this study. Namely, it is time and financially efficient (219). A statistical analysis plan was created to encourage methodological reproducibility.

Extracts of uptake data are used to answer whether patterns of attendance are changing. As the researching team were able to obtain data extracted from the database in a previously anonymised format this has further reduced time constraints.

Importantly, South West (SW) London was chosen for two reasons. Partly SW London was selected because of personal connections between the breast screening unit here and with a previous supervisor of the researcher but primarily as it routinely records ethnicity data and ethnicity is a key predictor of uptake required for this analysis.

Using a database for its ease of access has potential flaws – it could be biased or not appropriate. However, a requirement for a dataset and the main strength of this dataset was its recording of ethnicity. However, ethnicity information is solely self-reported data which could be considered subjective or less reliable (199). A limitation of this dataset is the lack of consistent recording of ethnicity and it was only

introduced to the centre in recent years. Where an ethnicity entry has been recorded it will be used throughout the woman's screening data. This will be discussed in the relevant chapter below. A further limitation is that using a SW London population may not be generalisable to the UK population, this will also be discussed in the relevant chapter later.

A mixed effects model has been selected due to the repeated nature of the measurements of the women. The analysis needs to account for any correlation between a woman's previous attendance and her future attendance without interest in any specific woman's attendance compared with another woman. Subsequently, random effects modelling was therefore used to account for similarities within women but also accounting for the fixed effects of the other covariates. Furthermore, mixed effects models are particularly useful when the dataset contains varying amount of information for different women, as in this one – some women may appear in the data just once, others may appear frequently, some may appear every three years, some may appear only twice (220, 221).

2.4.3 Questionnaire design

Within this section of the research project I developed a deductive questionnaire to measure personal characteristics, risk of BC and levels of IC among women. A deductive approach was chosen as it will use information from the previous studies and literature to help develop the appropriate questions (222). This was used to assess if personal demographics and BC risk profile are associated with either uptake of mammography or making an IC.

A questionnaire was chosen as it is the most practical tool to reach a large sample population within a short time frame (222). Some research suggests methods such as questionnaires are also the most useful in collecting personal information accurately as the researcher is not involved in the completion of the questionnaire and therefore the participant has little desire to complete the questions inaccurately or to answer with information they believe the researcher is hoping to find (223, 224). Nevertheless, social desirability bias is still found in some surveys and clearly some participants of surveys tend to present a favourable image of themselves (225), particularly for behavioural or personality questions (226). This increases the need

for indirect questioning on variables that are subject to social influence (227). A questionnaire typically has a poor response rate and also has a potential for response-bias, for instance only those with strong opinions or interest in breast cancer research will likely reply (228, 229). A questionnaire is also limited as there is no opportunity to follow up ideas or clarify answers where an interview research method would be more appropriate. Despite this, a questionnaire has numerous benefits for this research since many more women can be reached in an easy format.

2.4.3.1 How the items were selected

The items were selected in relation the literature and in relation to the findings of the secondary dataset. For example:

- The Tyrer-Cuzick (T-C) model was used to estimate a woman's personal risk of developing BC as discussed in the questionnaire chapter below (10). To estimate the risk of BC specific information needed to be acquired including information to calculate body mass index (BMI), details about menstruation, parity and menopausal status, medication use such as HRT and oral contraceptives and previous breast disease history including family history.
- Three sections reflected the components of IC. To ensure 'sufficient' knowledge, a woman must answer more than fifty percent of the questions correctly, meaning she will correctly answer five out of the nine questions (230). The questions assessing knowledge and attitude were based on previous work conducted by Marteau *et al.* (164). However they were adapted for use with mammography uptake. Behaviour was assessed by whether the woman has attended screening within the last three years.
- Personal characteristics questions were guided by national census survey questions deemed suitable and appropriate to ask participants. These questions were posed last to maximise participation and relate to predictors previously found to be associated with uptake of mammography (231, 232).

Items related to IC were based on the requirements for IC from Marteau *et al.* work, initially conducted in pre-natal screening, as described in further detail in chapters

below (164, 233). These items were then validated by Michie *et al.* (186, 234) before being used as part of decision aids in studies about screening programmes by Barratt *et al.* (192). In 2010, Smith *et al.* (188) used the measure of IC in a bowel cancer screening study and Matieu *et al.* (235, 236) adapted it for use in a BCS decision aid tool. These adapted questions have been used as closely as possible in this questionnaire.

2.4.3.2 Cognitive Interviewing

Cognitive interviewing is a valuable tool in the development of a questionnaire to identify and correct problems at an early stage (237). Not all respondents will process the questions in an identical manner (238). The cognitive interview will allow the researcher to consider how question items will function across a range of demographics.

The process of cognitive interviewing involves an assessment of how people answer and think about the questions posed to them during the questionnaire process. It is based on the understanding that answering a survey question requires iterative and complex information processing – starting with comprehension of the question, retrieval of information and then a judgement of motivation to answer the question truthfully (232). As a tool, it is useful to gain insight into how a potential research participant would answer them and to identify if the questions are being asked in an appropriate manner (239). Cognitive interviewing is useful to develop wording that is unambiguous and permits a successful response to what the researcher intended to ask (240).

In the interview setting, it was anticipated questionnaire respondents would like to offer qualification to their answers on items (241). Whether the comments were intentional, direct questions and feedback or incidental this provides important data for collection (241). I selected the ‘think-aloud’ technique, based on the origins of the Think Aloud Protocol and concurrent verbalisation (239, 242), here as it reduces the influence of interviewer bias and is conducted in an open-ended format. Furthermore, some research suggests that this concurrent verbalisation technique is less invasive and less disruptive than concurrent probing but provides more accurate insights than retrospective probing which relied on respondents recall (239). This is

important, particularly at the early developmental phase of the questionnaire to ensure every possible issue or response is accounted for (239). If the interview participant does not 'think-aloud' more instruction will be given before direct probing questions are used to prevent influencing the cognitive processes (243). If anything remains unclear retrospective probes will be used to clarify concurrent verbalisations (243).

Whilst I have not administered the questionnaire myself, the developed questionnaire will be of further use in future research on this topic and I hope will go on to inform practice. Once developed, this questionnaire could be used with women of screening age. Demographics, personal BC risk and IC for each woman could then be analysed to answer currently unknown questions about who is attending and who is making ICs within the NHSBSP. The results of this research will be vitally important for the NHSBSP, as the results will help to determine the future of the screening programme's invitation style and approach. It could be that a personalised invitation may be adopted, tailored to personal BC risk, or it could be that more focus is put onto ensuring ICs are made by all women attending. All of which will be beneficial for the women invited to screening.

All questionnaire design, development and cognitive interviewing will be conducted in English. Whilst this prevents non-English speakers participating in the research and potentially minimising the richness of the data obtained, there will be no attempt made to ascertain if translation of the materials maintains meaning at this stage, this is a limitation that must be acknowledged but one that could not be overcome at this timepoint. Further research to establish the effects of different languages and cultures would be preferable and important to conduct.

2.5 Overview of study flow

An overview of the study order and research questions is shown below in Figure 21.

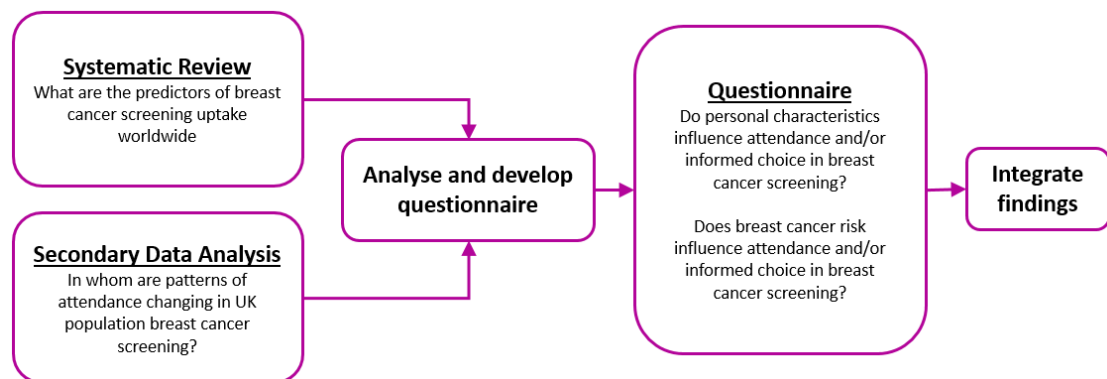


Figure 21: Research flow plan

2.4 Contribution to knowledge

The aim of this doctoral work is to contribute new knowledge to the research field through multiple outputs. This information should be used by future policymakers and in future research.

The first study will be a systematic review and analysis of international literature. This will combine all previous data on multiple different predictors and influencing variables for uptake of breast cancer screening.

To the authors' best knowledge, while many previous studies have looked at a small number of predictors in a sub-group of the population few have looked at all contributing factors to uptake in a worldwide setting.

A scoping literature search was conducted in Medline, Cochrane Library and EMBASE with 'predictors of attendance', 'predictors of non-attendance', 'uptake', 'mammogra*' and 'breast screening' used as search terms. This identified a number of relevant studies that were likely to be included in the final systematic review. However most papers focus on national programmes within Sweden, the UK or non-national programmes in the USA and this has identified similarities and differences in predictors of uptake across the world. Furthermore papers have focused on specific groups of women such as the 'over 65s' or ethnic minorities.

This systematic review will add to the previous work in the field of uptake of mammography research. It will be more recent and more innovative by firmly

establishing worldwide predictors of mammography uptake. My systematic review will incorporate and discuss the evidence for *all* types of women attending or not attending. It will not be limited to one single country and will also update the previous work which was conducted in the early 2000s.

The London screening centre data analysis will identify patterns of attendance within London and identify if they are changing. More specifically, it will identify predictors of attendance (and non-attendance) and will ascertain if these predictors are changing over time. This information is not currently known. Little research has been conducted using all population subgroups and all predictors in London. This research will form the basis of identifying if more research is needed to extend the sample to the UK population in order to be more generalisable.

To the authors' best knowledge, no questionnaire research has been conducted to answer similar questions as the ones posed. For the future literature it will be important to identify if there is an association between these factors (personal characteristics, demographics, IC and uptake). However, perhaps more importantly it will affect future breast screening practice by providing specific information about the women and their likelihood of attendance and/or making an IC in BCS.

To summarise, the review will add to the field of screening uptake research, identifying reasons for both attendance and non-attendance, and will provide important background information for more detailed investigation of changing screening patterns in London, UK. This is important for practice as specifics of who attends and who does not is currently unknown. The NHS aims to be equitable to all, however the NHSBSP needs answers about this 'unreached' group as it currently does not know who attends mammography. From this, and the questionnaire results, they can tailor information and ensure women are making informed decisions about attendance rather than being missed from the system.

Chapter summary

This section has described how the research is designed to fill the current literature gap.

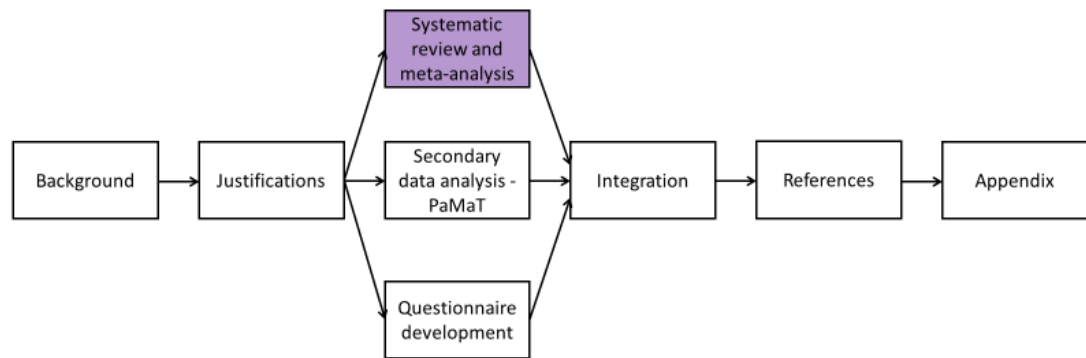
This thesis will identify predictors of attendance through a systematic review. The review will use international literature identifying predictors of uptake of breast cancer screening. Statistical analysis and narrative synthesis will be undertaken to indicate if uptake is changing. Summaries of the findings will be provided.

The results from the systematic review will be further developed within the UK context using secondary data from SW London on uptake and its predictors. The results of this analysis will identify if patterns of uptake are changing over time, and if so in whom.

Finally, a questionnaire will be developed to investigate whether personal characteristics and personal BC risk are associated with uptake of BCS and/or making an IC in breast cancer screening. Cognitive interviewing will be used so that the questionnaire is designed appropriately.

This chapter has described the methodology underpinning the research conducted. Justifications for each study design have been provided alongside strengths and limitations of the approaches discussed.

The next chapter explains in full detail the first phase of this research, the systematic review and the analysis of its data, both narratively and quantitatively.



Chapter 3: Systematic Review and Meta-Analysis

Introduction

This systematic review identifies current literature to provide a comprehensive understanding of predictors of mammography uptake. This systematic review is similar to a review conducted in 2008 (198) that sought to collate information about predictors of mammography uptake. Current literature contains many papers that examine predictors of uptake, but these papers tend to analyse individual predictors separately and only report influence of predictors individually. This review is not restricted by number or type of predictors and therefore provides a detailed overview.

3.1 Research question development

The research question for the review was 'What are the predictors of breast cancer screening uptake worldwide?' The sample population includes women invited for mammography screening worldwide. The outcome variable of interest is uptake of mammography.

3.2 Aims and Objectives

I aimed to identify the global predictors of mammography uptake. I performed a systematic review to identify, analyse and evaluate the quantitative data available for mammography uptake.

This review had the following objectives:

- To create a framework of predictors to highlight the different influences on uptake of mammography
- To produce a summary of descriptive statistics regarding predictors of mammography uptake
- To conduct a meta-analysis of available quantitative data, where possible
- To summarise remaining information narratively

3.3 Methods

3.3.1 Registration

My review was conducted in accordance with the protocol published on the 22nd November 2016 on the PROSPERO database (registration number: CRD42016051597) (206) which can be found in Appendix 8.1. This protocol outlined planned search strategies and inclusion criteria.

This review has been reported using Guidelines for Meta-Analysis and Systematic Reviews of Observational Studies (MOOSE) and Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria (244, 245).

3.3.2 Eligibility criteria and definitions

Quantitative studies that mentioned at least one predictor variable of mammography uptake were included. Studies had to quantitatively report uptake, attendance or compliance data, either current, previous or changes, to be included. Uptake was defined as the active 'taking up' of the breast screening invitation, attendance as the action of going to the breast screening appointment, and compliance as fully participating in the breast screening programme, as the national guidelines recommend.

This study was not restricted by country but was limited to only include studies written in the English language. Ninety percent of the study sample had to be within the country's screening programme age range. A publication date cut-off of 1987 was imposed to reflect the start of the UK breast screening programme, one of the first programmes of its kind (246). Studies that relied on self-report mammography uptake were excluded to improve the accuracy and reliability of any results, as some evidence has shown inaccuracy of those with average or low perceived BC risk in reporting their uptake correctly (247). The full inclusion and exclusion criteria can be found in Appendix 8.1.1.

3.3.3 Search strategy

A search strategy specialist at the University of Warwick library was consulted in the development of the search strategy and review protocol.

The following MeSH terms were identified. Terms were 'exploded' where appropriate in this review:

- Breast
- Screen*
- Early detection
- Mammogram*
- Mass screening
- Screening program*
- Direct to consumer
- Health screen*
- Adheren*
- Complian*
- Patient acceptance of healthcare
- Patient acceptance
- Patient access
- Attend*
- Uptake

These search terms were used in the search strategy in Medline as depicted in Table 5 below. The below search strategy was adapted where necessary for the relevant database. Searches were conducted on 28th November 2016 for Medline OVID, EMBASE and CINAHL, and on 5th December 2016 for PsychINFO, Web of Science and Cochrane Library. Reference lists of excluded reviews and meta-analyses were searched for relevant articles. Experts in the field were asked to assess the list of included studies. This provided additional papers of potential relevance (248-252). Search strategies for other databases are provided in Appendix 8.1.2.

Table 4: Search strategy used in Medline EMBASE on 28th November 2016

#	Searches	Results
1	Breast*.mp. or exp breast/	658985
2	(screen* or “early detection” or mammogram* or “mass screening” or “screening program*” or “direct to consumer” or “health screen*”).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading]	1116901
3	(uptake or adheren* or complian* or “patient acceptance of healthcare” or “patient acceptance” or “patient access” or attend*).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading]	1047679
4	1 and 2 and 3	6254
5	Limit 4 to humans	5748
6	Limit 5 to English language	5464
7	Limit 6 to yr=”1987-Current”	5391

3.3.4 Study selection

The search initially identified 9,607 unique articles. All articles were assessed by RC and independently assessed by a second reviewer, one of nine members of the research team.

A pair of reviewers independently conducted title/abstract assessments. Of these the Kappa (211) value was 0.61 before disagreement resolution via discussion or using a third reviewer where necessary to raise it to 100% agreement. The remaining 239 full-text articles were then independently assessed again by a pair of reviewers. Of these, the Kappa value was 0.74 (211) before disagreement resolution via discussion

or using a third reviewer were necessary to raise it to 100% agreement. The process and reasons for exclusion at the full text stage are provided in Figure 22 below.

There are significant differences in the way breast screening is organised in different countries (253). For instance, in the UK women are invited to screening every three years. The screening programme is run by the NHS and is free at the point of delivery. Other countries screen alternate years, some require insurance policies, and some rely on opportunistic presentation to clinicians. These differences impose a difficulty in the evaluation of worldwide trends in BCS. However, it is important to obtain an international perspective on the uptake of mammography. A perspective of each country's approach to screening was taken into consideration when comparing results.

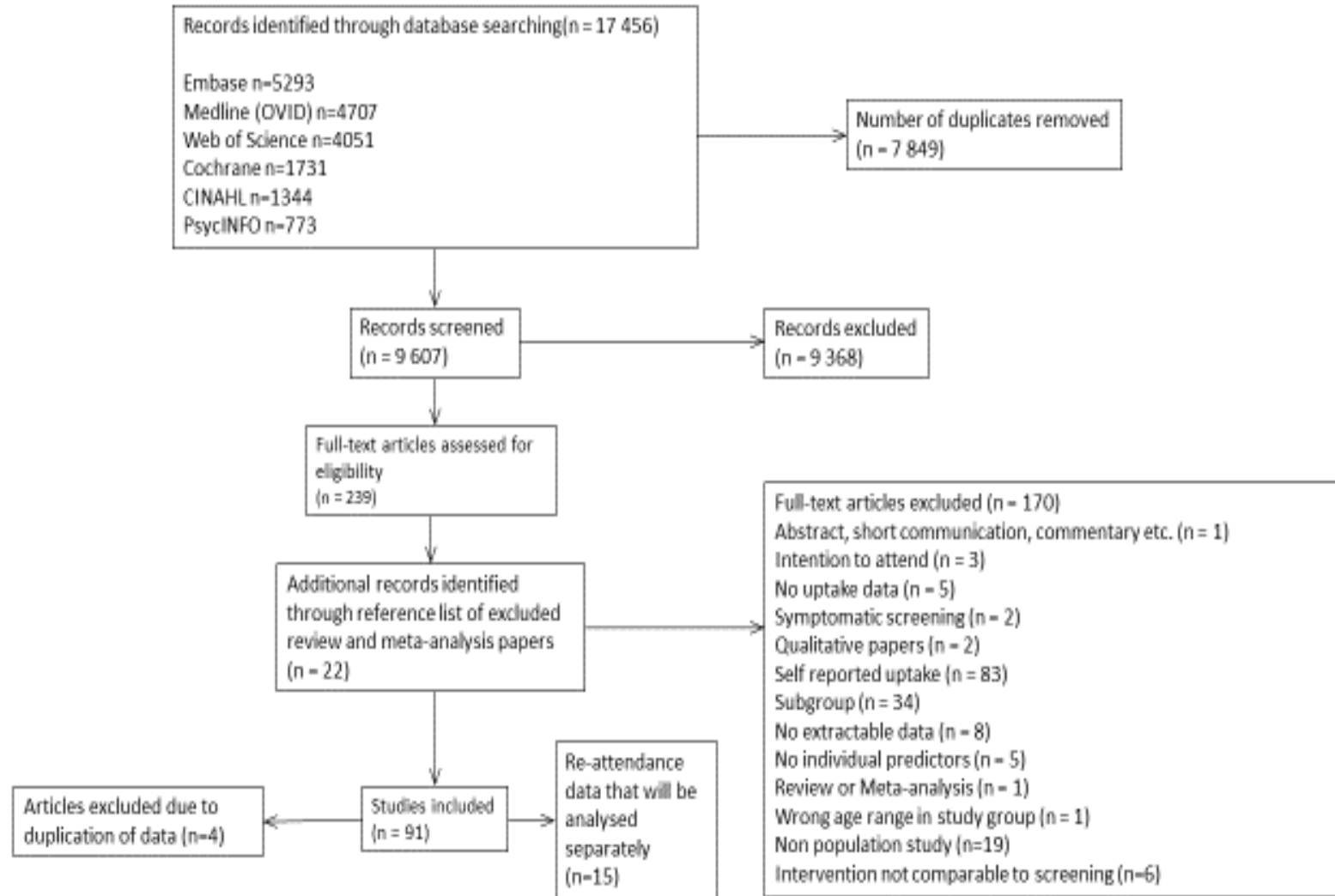


Figure 22: PRISMA diagram of included studies (254)

3.3.5 Data extraction

All data extraction was conducted by a single reviewer (RC) and checked by a second reviewer. Four authors were contacted where data were ambiguous (116, 121, 140, 255).

In the paper by Scaf-Klomp (116) the reported percentage values did not match the calculated actual numbers of attendees/non-attendees. Therefore, the author was contacted (25th October 2017) with no reply. Another paper (Tatla, 2003 (255)) has a similar issue where the reported data do not equal the calculated values and again the author was contacted (25th October 2017) with no reply. The paper by Szczepura *et al.* reported uptake from multiple screening rounds and it was uncertain whether data from women may be repeated in the study as they attended each round or each woman studied was unique. Szczepura was contacted on the 21st June 2018 with no reply. A typographical reporting error was identified in a paper by Freitas *et al.* as the numerator 805 of 13,951 participants did not equal the given 57.7% whereas a study sample of 8050 would have. Freitas was contacted on the 2nd July 2018 with no reply. The reported values have been used in any analysis or summary because the table may have accounted for missing data that has not been reported.

The extracted information is summarised in Appendix 8.1.4. Percent of uptake was extracted or calculated where necessary for both attending and non-attending women within each sub-category.

3.3.6 Quality assessment tool

As described in Section 3.4.1.2 above, the Quality Assessment Tool (QAT) was used as it provides a standardised means to assess study quality and an overall quality rating. It contains six domains: selection bias; study design; confounders; blinding; data collection methods; and withdrawals and dropouts. The QAT tool has been evaluated for content and construct validity and inter-rater reliability and meets accepted standards (256).

All QA appraisals were conducted by RC and were reviewed and checked by CN or LA. Assessors were not blinded for this process. Full description and guidance on how to use the tool has been published previously (215, 256).

3.4 Analysis Methods

Quantitative analysis for the systematic review was conducted using the statistical programme 'Stata 15.1' (257) and 'Review Manager 5.3' (258) at the University of Warwick. Review manager was used where data were dichotomised, Stata was used where sub-group meta-analysis had to be performed.

3.4.1 Data analysis

A narrative summary of the included studies was undertaken and is provided in Section 3.6.4. All studies had data extracted in the same manner, using the data extraction sheet as displayed in Appendix 8.1.4. The sample sizes for the narrative analyses ranged significantly with the smaller studies having approximately only 30 women included. More detail about the findings from the narrative analysis can be found in Appendix 8.1.5.

Random effects meta-analysis was conducted on predictors in each case where data were available from at least three studies (259). For predictors with fewer than three contributing studies or where quantitative data could not be meta-analysed, data were summarised narratively for each predictor of uptake.

Where data were dichotomised into groups, data were examined using Mantel-Haenszel random effects meta-analysis and the effect is presented as an odds ratio (OR). Where data were provided in more than two discrete groups, sub-group random effects meta-analysis was conducted to compare overall proportion attendances. Random effects models were used to allow for differences in the underlying proportions of attendance between studies (209).

3.4.2 Pooling data

In order to effectively meta-analyse data, certain information needed to be pooled into a wider sub-group to incorporate the maximum available data. For instance, the age group bandings presented in papers were merged into <50years, 50-59years, 60-69years and >70years. This was selected as a common age banding cut-off in the literature and incorporated the majority of the review data.

Country data were combined into North America, UK, 'other western' and non-western. This was chosen to create wider groups than the country level but to retain

key differences in data such as the requirement for insurance in North American screening programmes versus the UK.

Insurance records were pooled into three insurance types: private insurance, free insurance or uninsured. This minimised the number of differences to allow for grouping. Smoking information was combined into never versus ever (minimising the need for an occasional smoking category that only occurred in one paper). Some predictors were pooled into just two categories. For example, BMI groups were categorised as BMI<30 or ≥30kg/m². This grouping was used as BMI=30kg/m² is the cut-off used by NHS for obesity in adults. Women were pooled into either 'White' or 'other' ethnicity to maximise the data. Similarly, marital status data were pooled into 'married and cohabiting' or 'other'. Married and cohabiting women were combined replicating previous literature which had pooled the groups in the same manner. Extracted income data were merged into 'low', 'middle' and 'high' incomes. Some papers already provided the information in this way, others were combined manually. SES was also pooled into high, medium and low categories. Caution was needed as different studies would have classified 'high SES' differently to one another or used different scales. However, every effort was made to ensure consistency across the review.

Education was grouped into high, medium, low and no education as detailed in the provided studies.

3.4.3 Quantitative analysis

Forest plots were created to combine all data extracted for the systematic review by subgroup where appropriate. These showed significant heterogeneity (in the region of I²=68.0% to 99.9%). Funnel plots were used to assess for publication bias. All results are shown in Appendix 8.1.8.

A Bonferroni correction was used when several independent (or dependent) statistical tests were performed on a single dataset (260). In order to minimise the likelihood of wrongly rejecting the null hypothesis that there is no significant difference in uptake of mammography between groups of women (a type one error) the alpha value needed adapting. The alpha value for the entire set of *n* comparisons

is equal to taking the alpha value for each comparison α/n . The advantage of using this method to make the p-value more stringent is that it allows a reduced likelihood of type one errors. However, it may also make it harder to detect real associations within the data (261). Data for thirty-three predictors of uptake have been extracted and analysed for these results. The Bonferroni correction uses the typical level of significance ($p=0.05$) and divides it by the number of statistical tests you conduct on the data, in this case it is thirty-three. Therefore the Bonferroni adjusted p-value significance level is: $p = \frac{0.05}{33} = 0.00152$ (3 decimal places (dp)) (260).

3.5 Results

Study Characteristics

There was a trend towards more papers being published more recently (within the last 10 years with the exception of 2009) as seen in the table below.

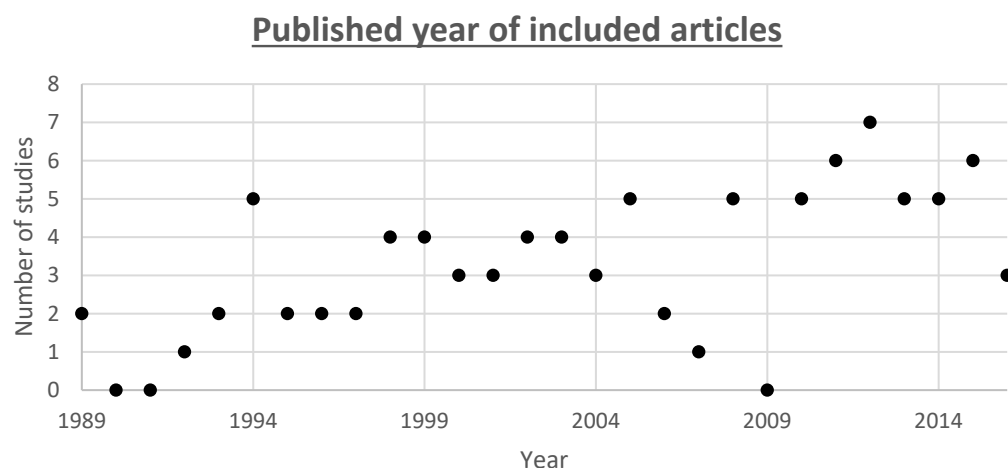


Figure 23. Graph to show the number of included studies per year published between 1989 and 2016

Twenty-six studies were found in the USA, closely followed by the UK ($n=21$). Thirty-nine studies were undertaken within European countries (excluding the UK). Studies were also published about Australia, North Korea, Israel and Canada.

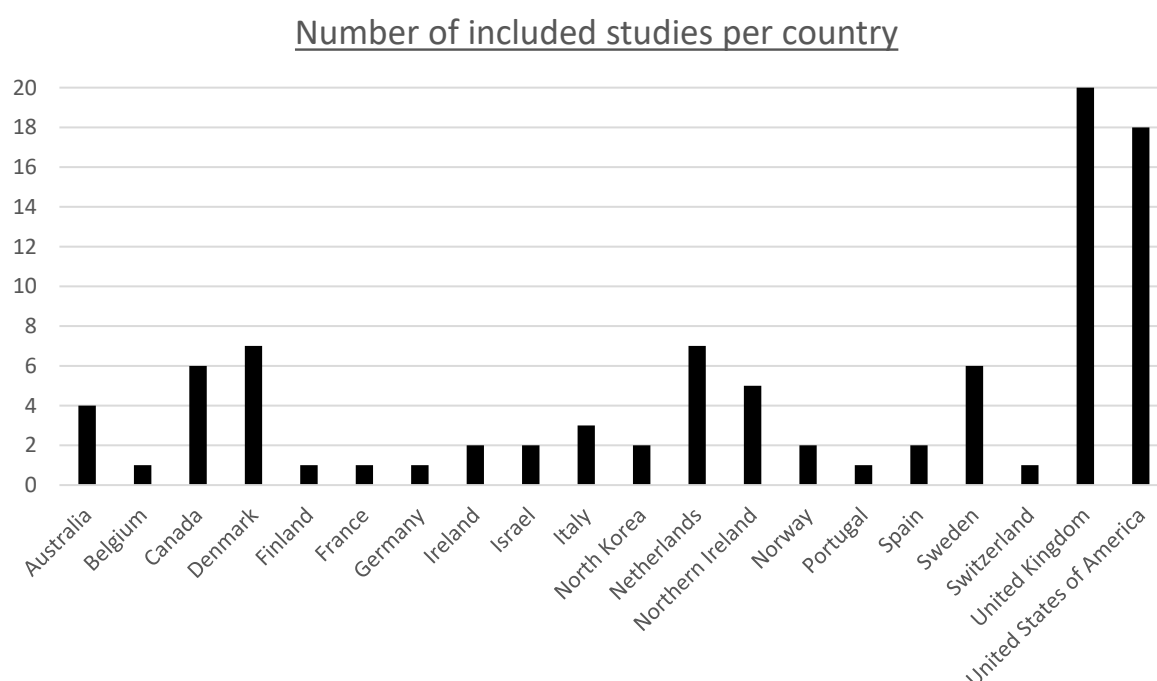


Figure 24. Number of included studies per country within the review. A table of country characteristics in terms of their screening program can be found in Section 1.1.

The majority of papers were retrospective cohort studies, followed by (prospective) cohort analyses and randomised controlled trials.

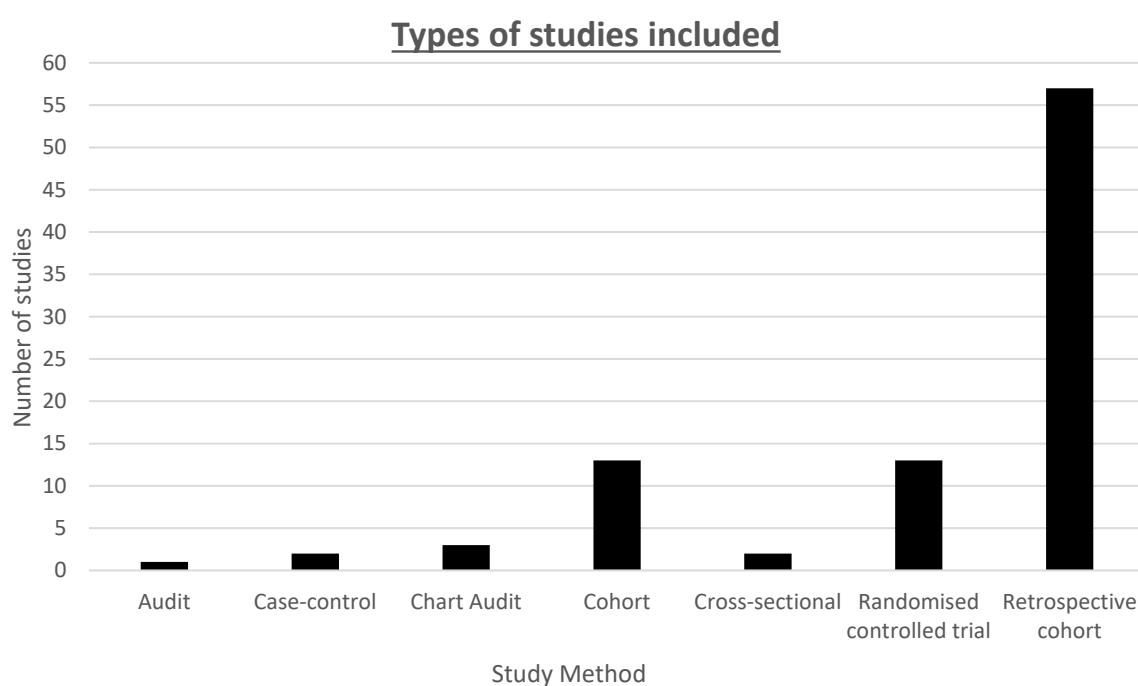


Figure 25. Number of studies included in the review by study type

Inconsistencies of the included papers

The majority of the included papers reported attendance data for national groups of women or large sub-sets of women. Most data reported were for general attendance at BCS programmes. A minority of papers were looking at re-screening of women. For instance they would report predictors of attendances of women who re-screened within the recommended guidelines (255) or participation following a false-positive result (262). Although they were included by the selection criteria these papers have purposefully been kept separate from those assessing general attendance and will be analysed independently.

Appendix 8.1.4 lists the studies in detail, organised by author.

3.5.1 Quality assessment results

An overall weak rating was given to 4/91 (4.40%) studies. These studies were all given 'weak' ratings in the sub-section "selection bias" meaning they were unlikely to have a representative sample of the population or a large number of invited participants did not participate. Results from these papers should be interpreted with caution. An overall moderate rating was given to 10/91 (10.99%) of studies. Five domains were rated as being of weak methodological quality in at least one study: selection bias = 9.89% of studies (9/91); confounders = 7.69% of studies (7/91); blinding = 1.10% of studies (1/91); data collection = 2.20% of studies (2/91); withdrawals = 2.20% of studies (2/91). Particular problems were encountered with study design as the majority of studies were not randomised controlled trials and therefore rated as being of moderate quality. The blinding domain was also often non-applicable.

Table 5: Quality Assessment Summary Table. QAT Rating key: 1 = STRONG = no weak ratings, 2 = MODERATE = one weak rating, 3 = WEAK = two or more weak ratings, NA = withdrawals and dropouts rating not applicable (215).

Author	Year	Ref.	Selection Bias	Study Design	Con-founders	Blinding	Data Collection Method	Withdrawals and Dropouts	Overall
Aarts	2011	(79)	1	2	1	NA	1	1	1
Andersen	2008	(262)	1	2	1	NA	1	NA	1
Aro	1999	(125)	1	2	1	NA	1	NA	1
Banks	2002	(133)	1	2	1	NA	1	NA	1
Bansal	2012	(248)	1	2	1	NA	1	NA	1
Beaber	2016	(263)	1	2	1	NA	1	NA	1
Berens	2014	(264)	1	2	1	NA	1	NA	1
Blanchard	2004	(55)	1	2	1	NA	1	NA	1
Bourmaud	2016	(265)	1	1	1	2	1	1	1
Bulliard	2004	(266)	1	2	1	NA	1	NA	1
Carney	2005	(267)	1	2	1	NA	1	NA	1
Chiarelli	2003	(249)	1	2	1	NA	1	NA	1
Chouliara	2002	(158)	3	2	1	NA	1	2	2
Coyle	2014	(114)	1	2	1	NA	1	NA	1
Euler-Chelpin	2008	(167)	1	2	1	NA	1	NA	1
Ferrante	2006	(268)	1	2	2	NA	2	NA	1
Fitzpatrick	2011	(269)	1	2	1	NA	1	NA	1
Fleming	2013	(168)	2	2	1	NA	3	NA	2

Author	Year	Ref.	Selection Bias	Study Design	Con-founders	Blinding	Data Collection Method	Withdrawals and Dropouts	Overall
Freitas	2011	(121)	3	2	1	NA	1	NA	2
Gandhi	2010	(270)	2	1	1	NA	1	NA	1
Gatrell	1998	(271)	1	2	3	NA	1	NA	2
Giordano	2008	(272)	1	2	1	NA	1	NA	1
Giorgi	2000	(273)	3	2	3	3	1	2	3
Gregory-Mercado	2007	(274)	1	2	1	NA	1	NA	1
Hurley	1994	(275)	1	1	1	2	1	NA	1
Hyndman	2000	(276)	1	2	1	NA	1	NA	1
Jean	2005	(277)	1	2	1	NA	1	NA	1
Jensen	2012	(278)	1	2	1	NA	1	NA	1
Jensen	2012	(279)	1	2	1	NA	1	NA	1
Jensen	2015	(144)	1	2	1	NA	1	NA	1
Jensen	2015	(280)	1	2	1	NA	1	NA	1
Kee	1993	(281)	2	2	2	NA	3	NA	2
Kinnear	2010	(282)	1	2	1	NA	1	NA	1
Kinnear	2011	(283)	1	2	1	NA	1	NA	1
Lim	2010	(284)	1	2	1	NA	1	NA	1
Liu	2014	(250)	2	2	1	NA	1	NA	1
Lagerlund	2015	(285)	1	2	1	NA	1	NA	1
Lagerlund	2002	(75)	1	2	1	NA	1	NA	1
Leung	2015	(286)	1	2	2	NA	1	NA	1
Makedonov	2015	(287)	1	2	1	NA	1	NA	1
Matson	2001	(288)	1	2	1	NA	1	NA	1
Maxwell	2013	(143)	2	2	1	NA	1	NA	1
May	1999	(289)	1	2	1	NA	1	NA	1
Mayer	1998	(290)	3	2	2	2	1	2	2
McCann	2002	(291)	1	2	1	NA	1	NA	1
McCarthy	1996	(292)	1	2	1	NA	1	NA	1
Meguerditchian	2012	(293)	1	2	1	NA	1	NA	1
Meldrum	1994	(294)	3	1	3	2	1	2	3
Moss	2001	(295)	2	2	1	NA	1	NA	1
Norum	2012	(296)	2	2	1	NA	1	NA	1
O'Byrne	2000	(141)	1	2	1	NA	1	1	1
Offman	2013	(297)	2	1	3	NA	1	2	2
Oh	2011	(298)	1	2	1	NA	1	NA	1
Ore	1997	(299)	2	2	3	2	1	2	2
O'Reilly	2012	(300)	1	2	1	NA	1	NA	1
Otten	1996	(301)	1	2	1	NA	1	NA	1
Page	2005	(302)	2	1	1	2	1	1	1
Peeters	1989	(303)	1	2	2	NA	1	NA	1
Peeters	1994	(304)	2	1	1	1	1	2	1
Pelfrene	1998	(305)	1	2	1	NA	1	1	1
Pinckney	2003	(251)	1	2	1	NA	1	1	1

Author	Year	Ref.	Selection Bias	Study Design	Con-founders	Blinding	Data Collection Method	Withdrawals and Dropouts	Overall
Renshaw	2010	(135)	1	2	2	NA	1	1	1
Rodriguez	1995	(306)	1	2	1	NA	1	NA	1
Rutten	2014	(307)	1	2	1	NA	1	NA	1
Rutter	1997	(308)	1	2	1	NA	1	2	1
Scaf-Klomp	1995	(116)	2	2	1	NA	1	NA	1
Seeley	1994	(309)	2	2	1	NA	1	2	1
Segnan	1998	(310)	3	1	1	2	1	2	2
Shippee	2012	(311)	2	2	1	NA	1	NA	1
Simon	2001	(312)	1	2	1	NA	1	1	1
St-Jacques	2013	(313)	1	2	1	NA	1	NA	1
Szczepura	2008	(140)	1	2	2	NA	1	NA	1
Taplin	1994	(314)	1	1	1	1	1	1	1
Tatla	2003	(255)	1	2	1	NA	1	NA	1
Taylor	1999	(315)	3	1	3	2	1	2	3
Taylor-Phillips	2013	(166)	1	2	1	NA	1	1	1
Tornberg	2005	(316)	1	2	1	NA	1	NA	1
Ulcickas	1999	(169)	1	2	1	NA	1	NA	1
Vaile	1993	(171)	2	2	1	NA	1	NA	1
Valanis	2003	(317)	1	2	1	NA	1	NA	1
Vermeer	2010	(252)	1	2	1	NA	1	NA	1
Vidal	2014	(318)	2	2	1	NA	1	NA	1
Visser	2005	(319)	1	2	1	NA	1	NA	1
von Euler-Chelpin	2008	(320)	1	2	1	NA	1	NA	1
Wilf-Miron	2011	(321)	1	2	1	NA	1	NA	1
Werneke	2006	(322)	3	2	3	NA	1	NA	3
Williams	1989	(323)	2	2	1	NA	1	NA	1
Woodhead	2016	(324)	1	2	1	NA	1	NA	1
Yarnall	1992	(325)	3	2	2	NA	1	NA	2
Zackrisson	2004	(131)	1	2	1	NA	1	NA	1
Zidar	2015	(163)	1	2	1	NA	1	NA	1

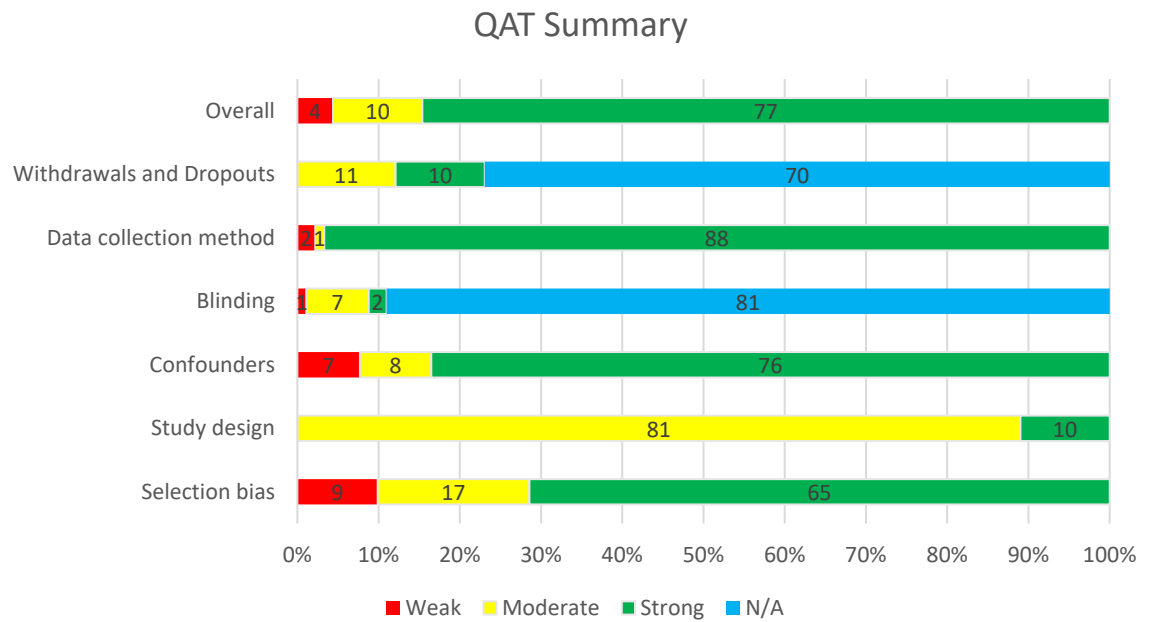


Figure 26. Overall summary of QAT scores.

The majority (81.6%) of studies were rated as ‘strong’ quality on the QAT tool which was considered reliable. ‘Moderate’ methodological quality was given to 12.6% of the studies (with one weak rating in one section of the QAT tool). Six studies (5.8%) were given an overall ‘weak’ quality rating as they had been given more than one weak section rating.

Quality assessment ratings of
included studies

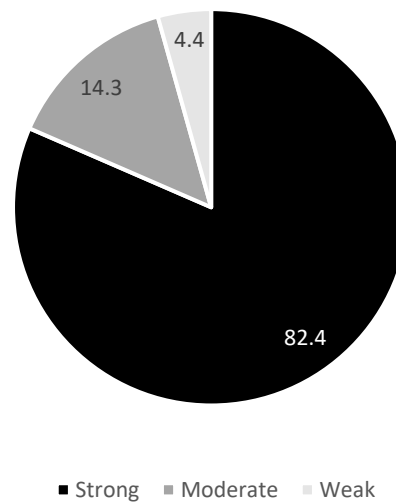


Figure 27. Percent of quality assessment ratings as 'strong' (n=77/91), 'moderate' (n=10/91) or 'weak' (n=4/91) for the included studies.

As shown in *Table 7* most of the papers included multiple predictors. Many papers were also investigating uptake by women with different demographic characteristics.

3.5.2 Constructs of the review

Table 7 below shows the frequency of studies identifying different overarching groups of predictors in BCS. A Venn diagram and the number of studies containing each of the combinations of the four constructs is provided below.

The construct coded for each article was assessed by myself and was dependent on the type of data extracted for the article in question. For instance, if data about uptake dependent on age was extracted then this would be coded as ‘demographics’ data. If data about uptake dependent on the use of oral contraceptives, this would be coded as ‘health status or medication’.

Table 6. A table of the number of studies containing each of the combinations of the four constructs of predictors of BCS uptake. The constructs consist of factors as shown in Appendix 8.1.3.

One	Two	Three	Four	N
Demographics				36
Healthcare system				2
Health status or medication				7
Interventions				13
Demographics	<i>Healthcare system</i>			6
Demographics	<i>Health status or medication</i>			16
Healthcare system	<i>Health status or medication</i>			2
Demographics	<i>Healthcare system</i>	<i>Health status or medication</i>		7
Demographics	<i>Health status or medication</i>	<i>Interventions</i>		1
Demographics	<i>Healthcare system</i>	<i>Health status or medication</i>	<i>Interventions</i>	1

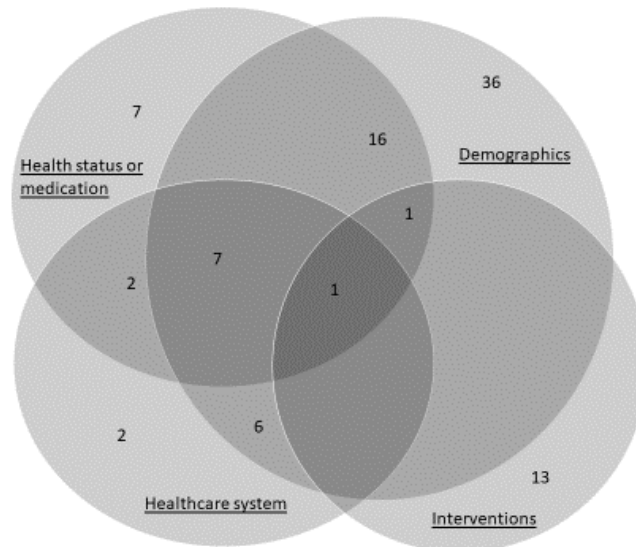


Figure 28. Venn diagram depicting the number of included studies for each overarching construct of predictors. Individual included predictors are defined in Appendix 8.1.3

Findings

Overall methodological ratings ranged between weak (if study had been given two or more ‘weak’ section ratings), moderate (if study had been given one ‘weak’ rating) and strong (if no ‘weak’ ratings were allocated).

Where appropriate, the number of women included in a study has been provided in brackets. For instance, a percentage may be provided as a rate of uptake, the number of women in absolute terms is given in the brackets (n=x) immediately afterwards for completeness.

A summary table is presented at the end of this section. For all meta-analysed data, funnel plots were conducted and are accessible in Appendix 8.1.7.2. For each predictor, the points did not solely lie within the 95% confidence interval plot and therefore publication bias is present.

Heterogeneity was high for all meta-analyses, between 68% and 99% meaning significant variation across the included studies was due to heterogeneity rather than chance. However, due to the large sample size of the included studies this is understandable as each estimate is extremely accurate yet quite disparate from

another estimate likely causing the high heterogeneity score. Instead, these tests provide evidence that there is significant variation across BCS programmes.

Some predictors did not provide enough data to quantitatively analyse their effect on mammography uptake and instead data have been appraised narratively. Each contributing study or group of studies is briefly described as an overall summary with more detailed narrative analysis found in Appendix 8.1.5.

Some papers could not be combined with the quantitative data. Studies that used data which sums to 100% (i.e. giving characteristics of the attendee population rather than attendance rates for the invited population) are presented in Appendix 8.1.6.

3.5.1 Demographics

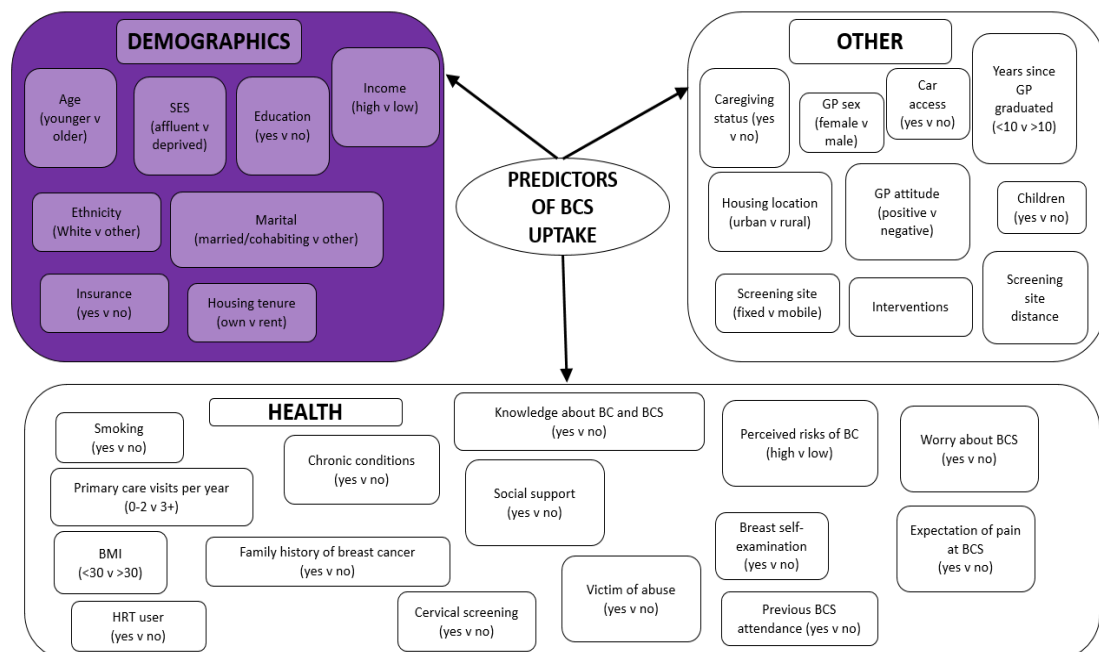


Figure 29. In this section demographic predictors of uptake will be discussed

3.5.1.1 Meta-analysis

Marital status

Marital status groups were combined based on similarities between groups to investigate if being married/living with a partner was a significant predictor of attendance at BCS. Groups were therefore divided into 'married or cohabiting' and 'other'. Data were pooled based on the hypothesis that marital status influences uptake by means of social support.

The odds of attending BCS for women who are married or cohabiting were 60% higher than for women who were not, OR 1.60 (1.38, 1.85), $p < 0.000152$.

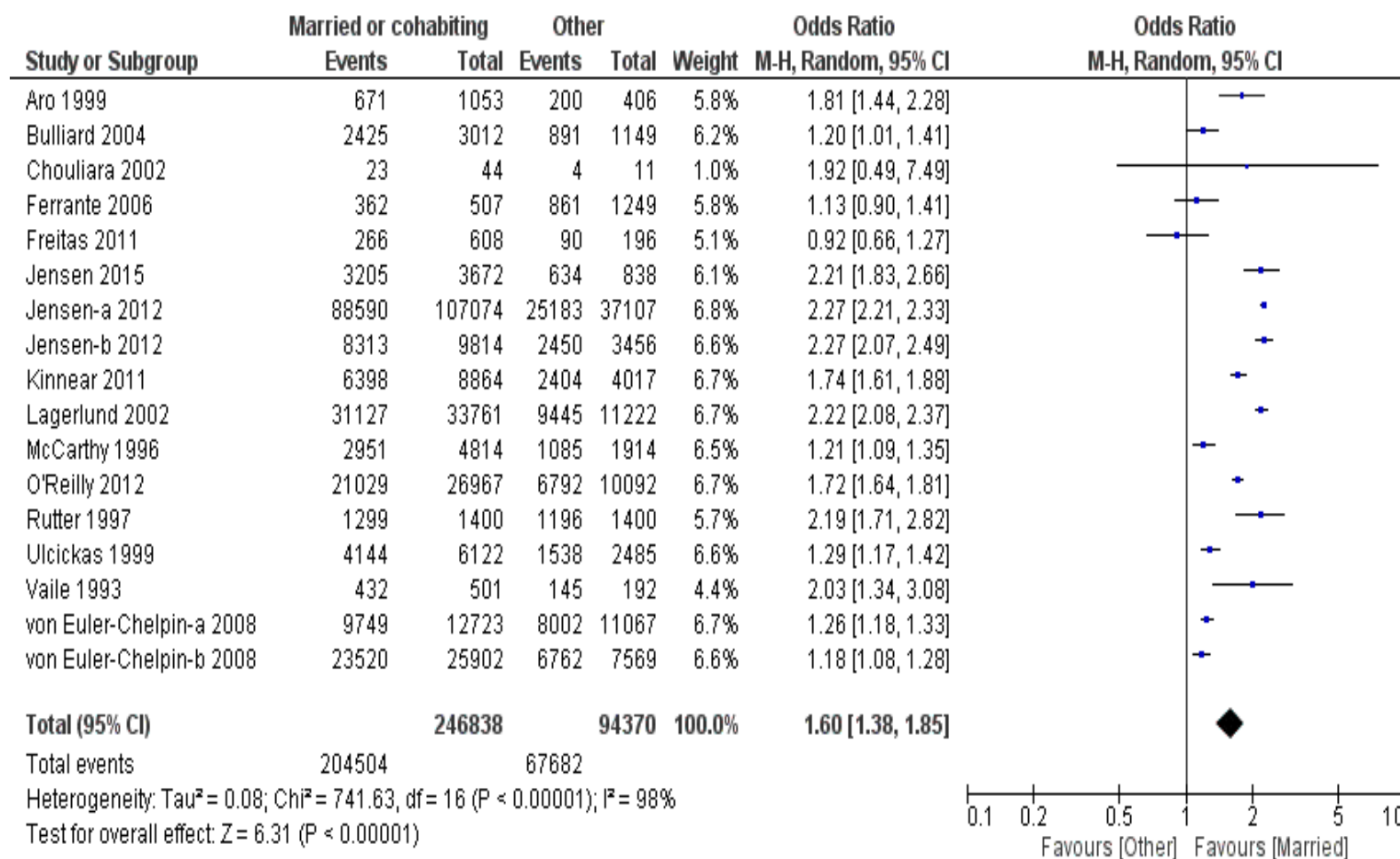


Figure 30. Meta-analysis results for marital status data. Cohabiting includes married women also.

Four studies provided quantitative data on ethnicity that could be meta-analysed (55, 248, 289, 292). There was no significant difference found between attendance of White and non-White women, OR 1.08 (0.87, 1.35), $p < 0.000152$.

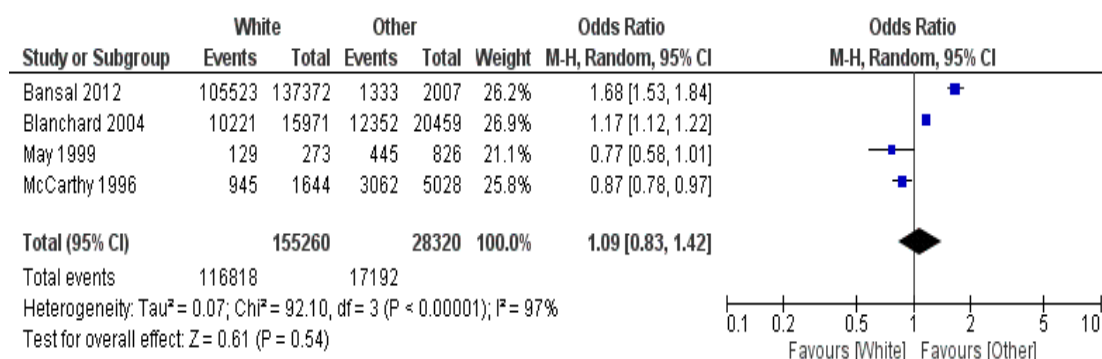


Figure 31. Meta-analysis results for ethnicity data

Age

After removing data that were inconsistent with the specific research question, quantitative analysis was conducted on the remaining studies (62, 79, 131, 133, 135, 140, 144, 166, 255, 279, 283, 296, 300, 301, 303, 304, 306, 309, 326).

The meta-analysis found, on average, 79% (75, 83%) of women aged under fifty attended BCS compared with 75% (68, 81%) of women aged 50-59 years, 71% (64, 78%) of women aged 60-69 years and 63% (47, 78%) of those aged over seventy. Uptake does not appear to vary significantly by age group although there is a slight decreasing trend.

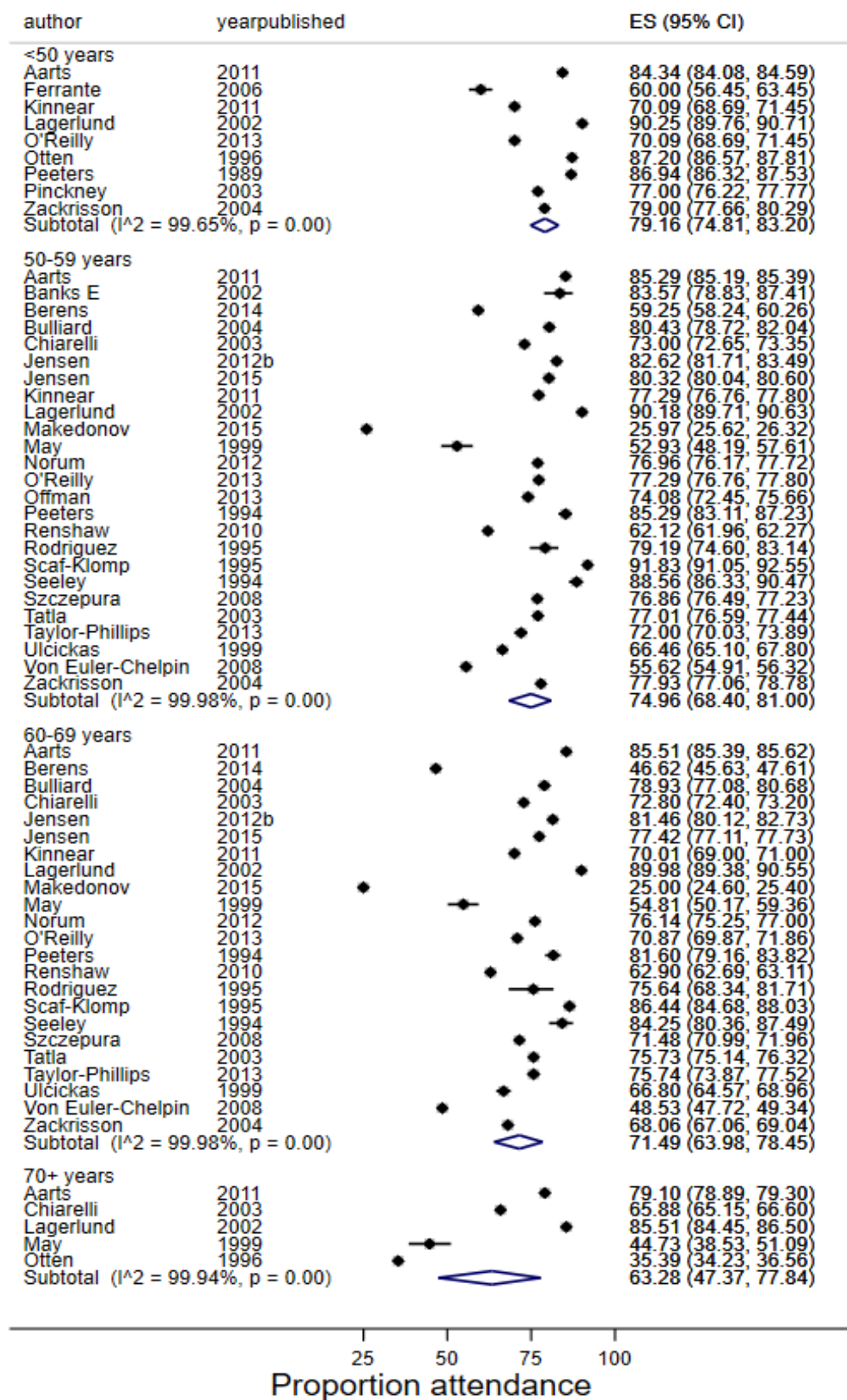


Figure 32. Proportion attending mammography by age group.

SES

Ten studies provided data on SES for the purpose of this analysis (79, 133, 135, 140, 141, 171, 255, 266, 276, 287). Any data that could be merged into three groups, high, medium and low SES, were used for the quantitative part of the analysis. Attendance by women of lower SES was 60% (48, 71%) compared with 73% (61, 84%) for women of medium SES and 73% (54, 88%) for women of high SES. There was no significant difference in uptake between SES categories.

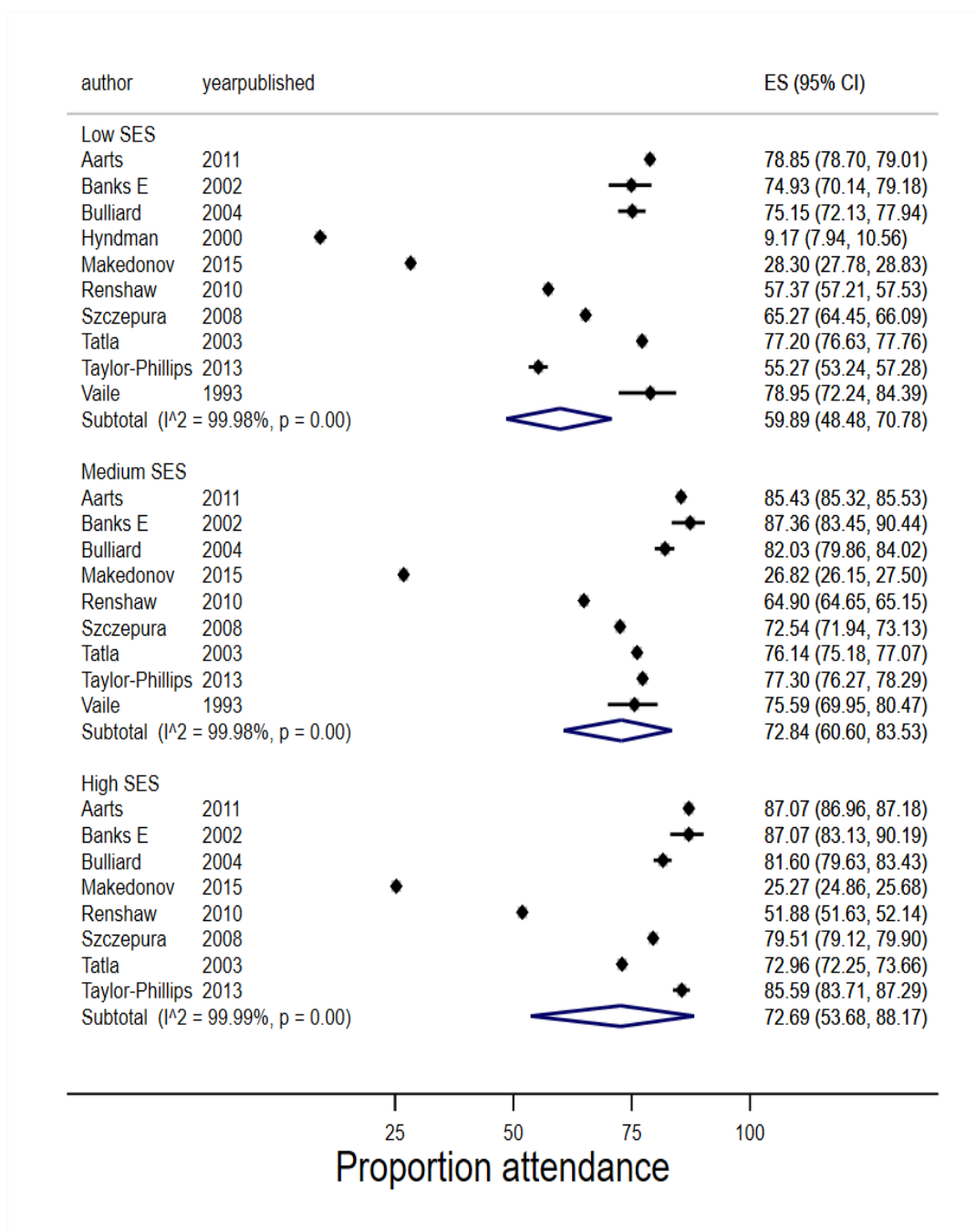


Figure 33. Proportion attending mammography by socioeconomic status

Income

Income data were extracted from eight studies (75, 125, 169, 263, 278, 279, 327, 328). Of women who have a low income, 64% (54, 74%) attended BCS compared with 73% (63, 82%) of women with a medium income and 73% (62, 82%) of high income women. This finding is non-significant as the confidence intervals are overlapping.

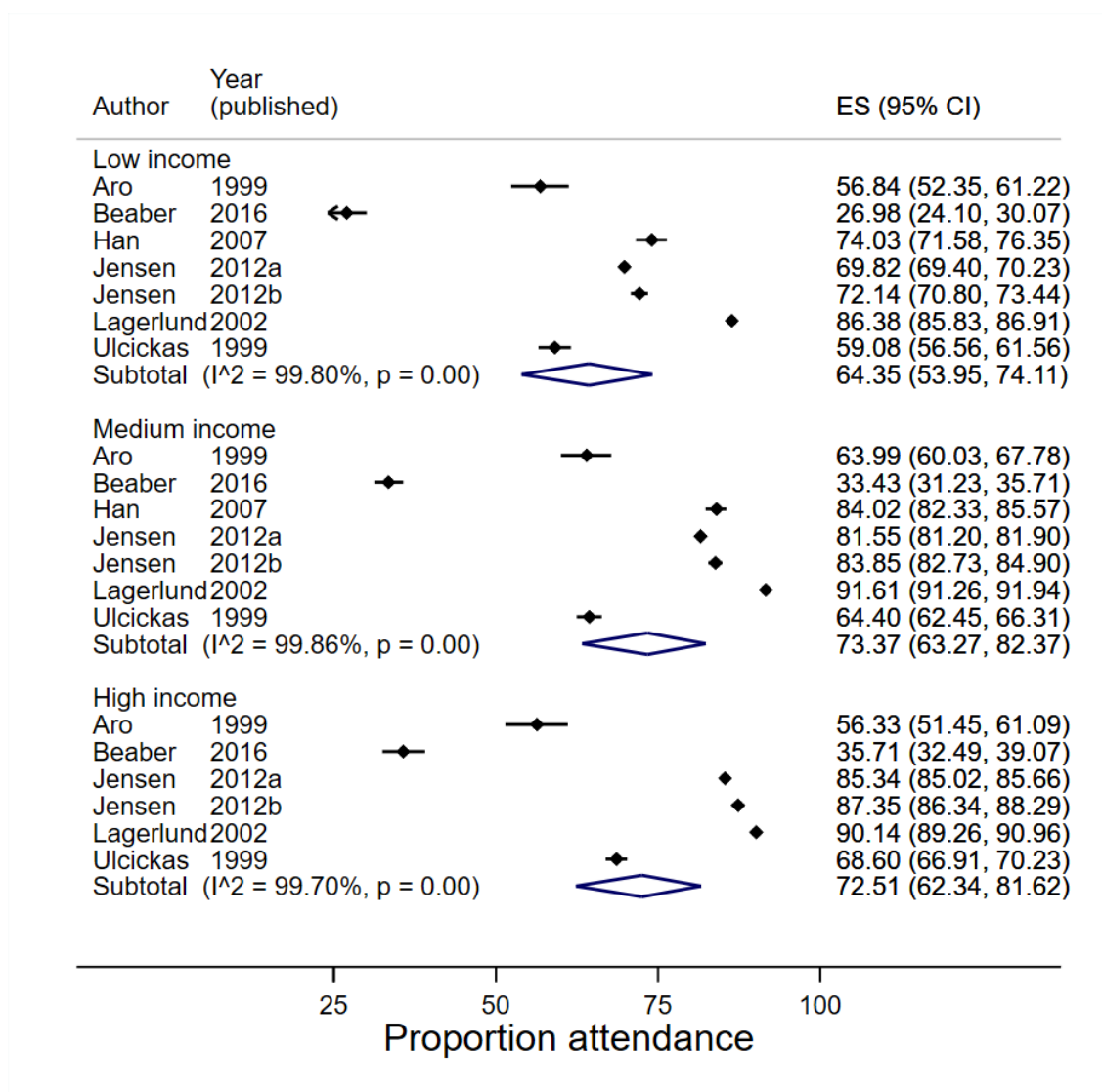


Figure 34. Proportion attending mammography by income level.

Housing tenure

Four studies offered data on housing tenure (75, 278, 283, 300). Data were merged into women who either own or rent their homes (privately or socially).

Forest plots were constructed as shown in Figure 35. On average, 85% (77, 91%) of women who owned their own house attended screening compared with 71% (62, 80%) of women who rented privately and 61% (60, 63%) of women who lived in social rented accommodation. Based on overlapping confidence intervals, this indicates no statistically significant difference in uptake between the group of women who rented their housing privately and the other groups. A statistically significant difference was

observed between women who own their own house and those who live in social rented accommodation.

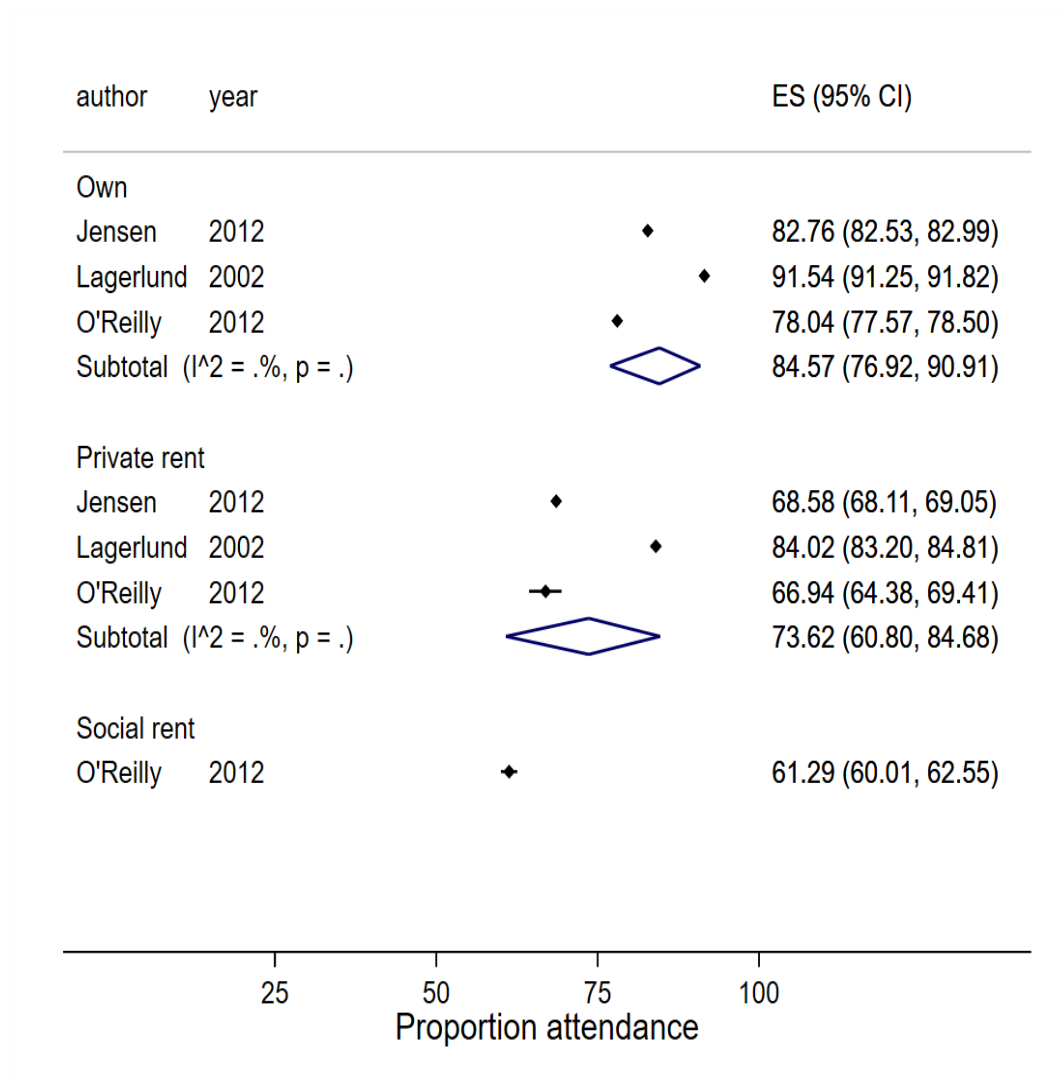


Figure 35. Proportion attending mammography by housing tenure data.

Education

Level of education was analysed as a potential predictor using data from nine studies (75, 121, 125, 144, 158, 168, 266, 268, 326). Data were combined into high, average or low levels of education. Women who had up to secondary school education were defined as 'low education', those who had more than secondary school education but less than university education were classified as 'average education' and women with university education were classed as having 'high education'.

Of highly educated women 71% (66, 77%) attended BCS. Of women who had an average education, 75% (70, 80%) attended, and amongst those with low education 71% (63, 78%) attended. Of women without education 75% (60, 88%) attended. This suggests that education level is not a significant predictor of BCS uptake.

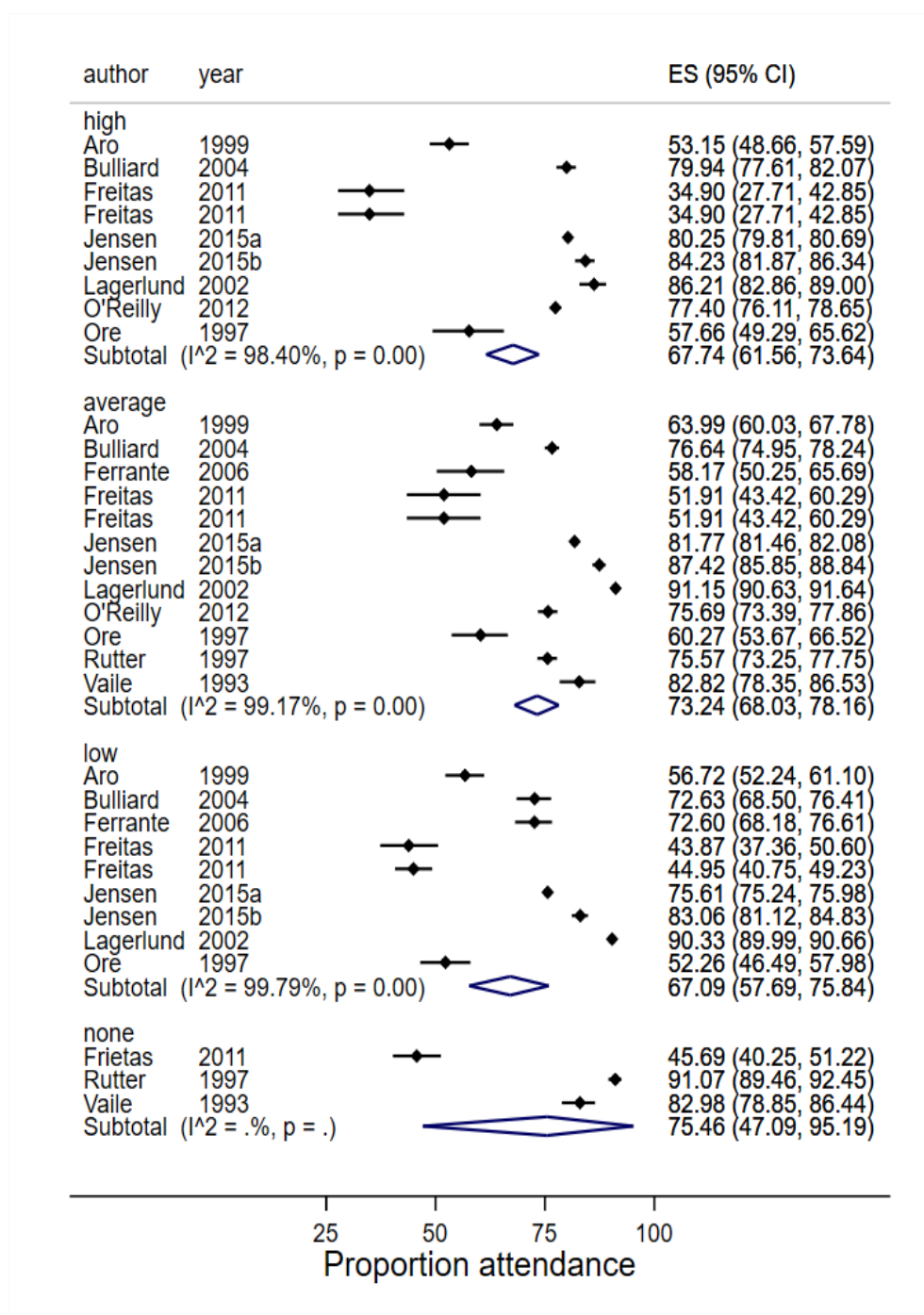


Figure 36. Proportion attending mammography by level of education.

Insurance

Data from seven studies provided data on insurance and mammography uptake (55, 263, 268, 284, 298, 315, 321).

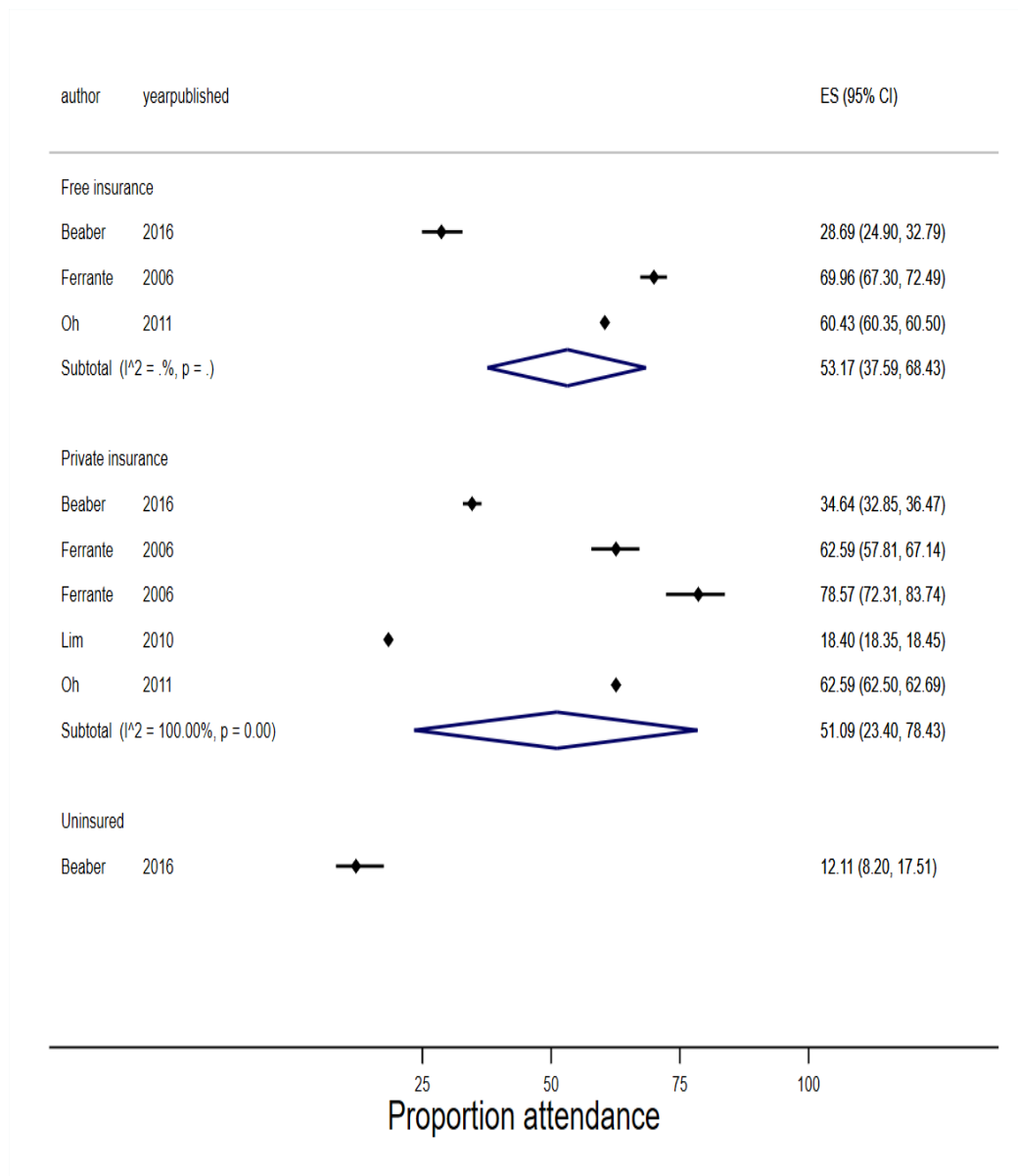


Figure 37. Proportion attending mammography by insurance status.

Of women who had free or national health insurance, 53% (38, 68%) attended BCS compared with 51% (23, 78%) and 12% (8, 18%) of women with private insurance and no insurance respectively. Unsurprisingly women without health insurance showed significantly lower rates of uptake. Data from other included papers that could not be analysed quantitatively with the above data also supports the argument

that women with insurance are more likely to attend than women without insurance (284, 298, 315, 321).

3.5.1.2 Narrative analysis findings

Marital status

Two papers provided data about marital status and uptake that could not be combined into the meta-analysis (299, 329). These papers suggest that the majority of women who attended screening were married (56.3% in the Israel paper (299) and 64.1% in the USA study (329)).

SES

Overall the narrative data supports the idea that uptake increases with affluence, whether that be measured by deprivation level or by employment status. Additionally, two studies found SES to be significantly associated with uptake of mammography. However, our meta-analytic findings did not find a significant result. This could be because SES definitions varied considerably between papers (75, 140, 166, 276, 278, 283, 288, 299, 321, 330).

Ethnicity

The narrative data highlights lower uptake in minority ethnic women, this is contradictory to my meta-analytic findings which found no significant difference between women of different ethnicities (329). The narrative data found increased uptake in women whose preferred language is English (255). One study investigated the impact of religion and found lower uptake in atheist women (331). Six of the seven papers that provided data about nationality state uptake is higher in native women (140, 141, 169, 299, 320, 321). The exception found in Germany, uptake was highest among women of Turkish origin (264).

Insurance

Two studies from Israel (321) and USA (263) found lower uptake in uninsured women which is directly comparable to the significantly lower uptake in uninsured women found by my meta-analysis. Contradictorily, lowest uptake was observed in Korean women who could obtain screening for free (298).

Age

The data available about the effect of age on uptake is inconsistent. This finding was also observed in the meta-analysis results where a non-significant finding was found between age groups (140, 144, 158, 163, 167, 171, 267, 272, 284, 285, 299, 300, 302, 307, 313, 315, 317).

3.5.1.3 Summary

The meta-analysis results found women who were married were more likely to attend BCS. Uninsured women were significantly less likely to attend compared with women who were insured. Surprisingly, meta-analyses showed that age, SES, ethnicity, income, housing tenure and education were not found to be significant predictors of mammography attendance.

The narrative analysis found similar results in so much as married women were more likely to attend and minority ethnic or uninsured women were less likely to attend. The narrative paper did go on to suggest a lower uptake in atheist women, something the meta-analysis did not investigate due to limited data. There were inconsistent findings for age which is comparable to the non-significant result from the meta-analysis. Additionally, uptake was found to increase with affluence, something that was not supported with my meta-analysis results.

For more detail, please see Appendix 8.1.5.1.

3.5.2 Health

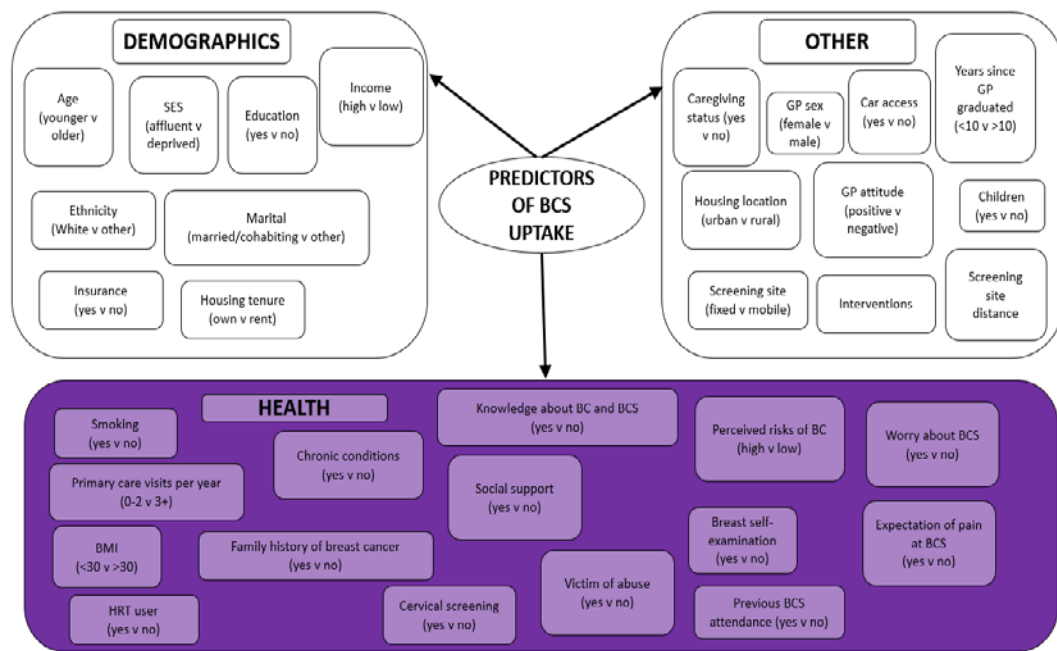


Figure 38. In this section health related predictors of mammography attendance are discussed

3.5.2.1 Meta-analysis

Data from studies reporting smoking status were extracted (125, 266, 268).

A meta-analysis was conducted to compare smoking status groups and is shown in Figure 39. Women who smoke have 38% lower odds of attending [OR 0.62 (0.45, 0.86), $p < 0.000152$] compared to women who do not smoke.

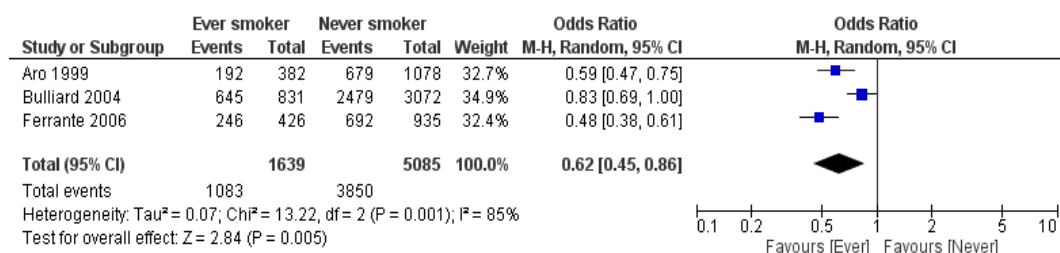


Figure 39. Meta-analysis results for smoking data.

Data regarding general illnesses and chronic health conditions were extracted for this review (125, 144, 250, 293, 308, 322, 324, 326).

Women who had chronic conditions were 30% less likely to attend BCS than women who did not have chronic conditions, OR 0.70 (0.61, 0.81), $p < 0.000152$ as seen below in Figure 40.

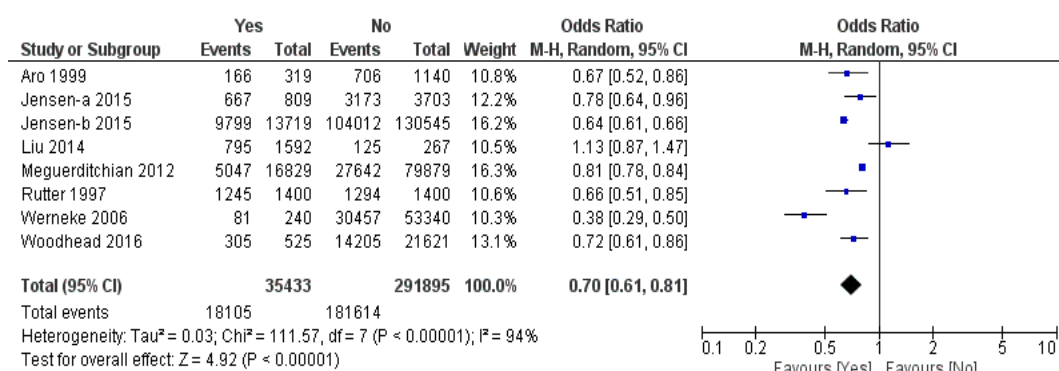


Figure 40. Meta-analysis results for chronic conditions data.

Data from studies providing information on primary care visits were extracted (121, 263, 268). Groups were categorised as '0-2 visits' or '3 or more' within the last year. This review found women with 0-2 primary care visits in the last year were 73% more likely to attend BCS, OR 1.73 (1.06, 2.84), $p < 0.000152$ compared with women who attended 3 or more times.

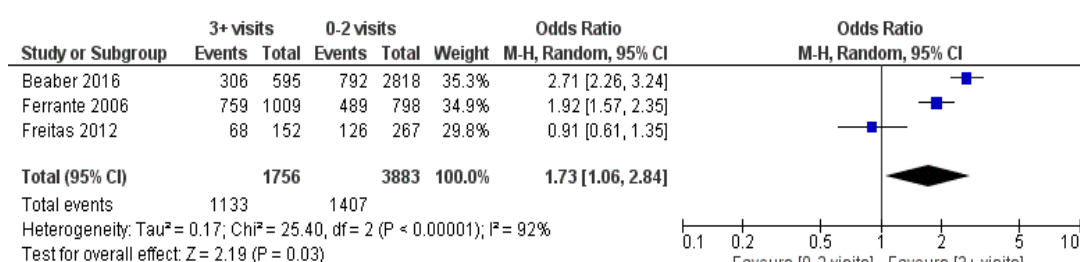


Figure 41. Meta-analysis results for primary care visit data

The quantitative data available for BMI were extracted from (263, 266, 268). There was no significant difference in attendance between obese and non-obese women, OR 0.86 (0.71, 1.05), $p < 0.000152$.

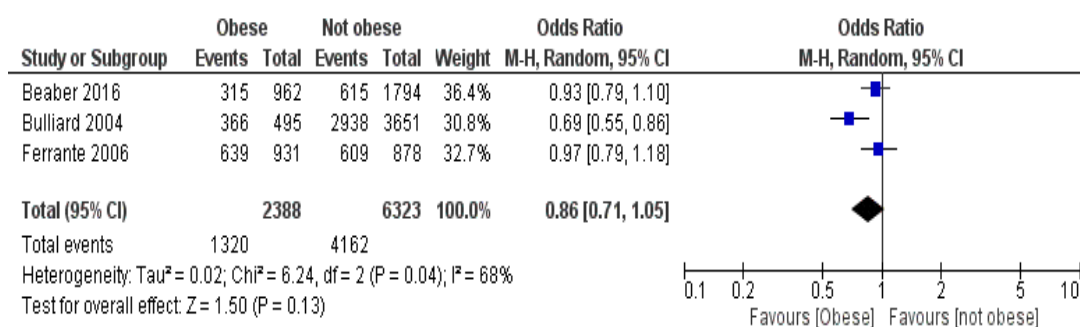


Figure 42. Meta-analysis results for BMI data

3.5.2.2 Narrative analysis findings

Comorbidity

Five studies investigated attendance in relation to comorbidity suggesting mixed results (144, 322, 324, 326, 332). On balance it appeared that other illnesses do not necessarily affect BCS attendance. This is contrary to my meta-analysis results above which suggested that women with chronic conditions were less likely to attend BCS.

HRT

The narrative results are mixed with studies reporting the opposite effects of HRT on uptake. However, these studies are conducted in disparate settings (Australia and UK) and perhaps there are other influencing factors that cannot be accounted for here (141, 309).

Family history

The results about the effect of family history on uptake are variable and further research needs conducting (141, 168, 268, 306).

Previous health behaviours

Previous attendance at cervical or breast screening and breast self-examination has been associated with variable rates of mammography uptake (125, 166, 171, 255, 289, 292, 293, 295, 298, 306, 308, 332, 333).

Psychosocial

Uptake was found to be higher in women who knew the preventative role of BCS (306) and in women who believed BCS did more good than harm (281). Uptake was also reportedly higher in women who believed their risk of BC was moderately higher compared to women who did not think their risk was higher (125, 306). Of women who expected BCS to be painful, uptake was lower (125).

Attendees were found to be more likely to have social support – either instrumentally or emotionally (280).

Violence

Of women who experienced intimate partner violence, victims were more likely to be up-to-date with mammogram screening (270).

3.5.2.3 Summary

From my meta-analysis results, women who had never smoked, had no chronic conditions or had three or more primary care visits annually were found to be more likely to attend BCS than women who had smoked. BMI was not found to be a significant predictor of mammography uptake.

Narratively, there were mixed reports about the effect of co-morbidity, HRT and family history on mammography uptake. Women who had attended other preventative services were more likely to attend mammography. Women who knew the role of BCS, believed their risk to be moderately high or believed BCS did more good than harm were more likely to attend. Women who expected mammography to be painful or those who worried about mammography were less likely to attend.

For more detail, please see Appendix 8.1.5.2.

3.5.3 Other Predictors

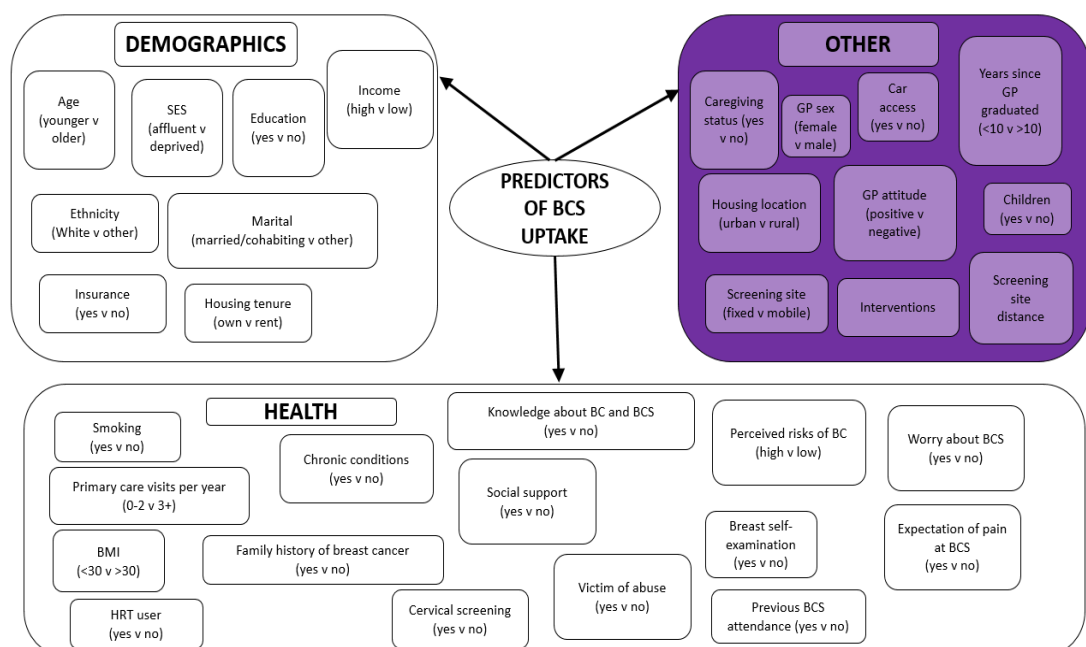


Figure 43. In this section other predictors related to mammography attendance are presented

Caregiving

The odds of attending BCS were 28% higher for women who were care-givers for 1-19 hours per week compared with women who were not care-givers, OR 1.28 (1.19, 1.38) (282). There was no significant difference found in attendance for women who spend more hours per week as a care-giver (282).

GP

Data about physician characteristics were extracted to investigate if this was associated with uptake of BCS. Overall, 37.9% of women attended if they had a female physician compared with 41.7% of those with a male physician (279, 293). 82.0% of women with a physician with a positive attitude attended compared to 77.5% of women with a physician with a negative attitude (279). 24.3% of women whose GP graduated less than ten years ago and 25.6% of women whose GP graduated ten or more years ago attended BCS (287).

Urban-rural

The majority of studies found uptake was higher in women living in rural settings (141, 168, 171, 286, 300). Only one study reported higher uptakes in urban-dwelling women and this study was conducted in Australia where distances are vast. However, in the case of rural women attending more it could be due to a confounding factor such as they are more likely to own a car, which was associated with uptake below or they may be different women to those living in urban settings, such as more affluent women.

Screening site

The studies reviewed narratively suggested that uptake is higher in women who live close to the screening site. Uptake is also increased for women who can attend a mobile screening site. This may be because of increased convenience for the woman (141, 292, 297).

Interventions

Interventions that included a decision aid resulted in no significant difference in uptake (265). Uptake was higher in women who received a reminder (either by postcard, letter or text-message) (302, 318, 323, 334, 335). Uptake was also higher in groups who received an appointment time (275) and those who received tailored information – either to address barriers to attendance or by using their previous screening history (294, 317). Incentivised uptake studies did not find a significant difference in uptake behaviour between those who received an incentive and the control groups (332).

Car

Uptake was found to be higher for women who had access to a car (121, 278, 300).

Children

The results of studies investigating the effect of children on uptake was variable (75, 158).

3.5.3.3 Summary

There are no meta-analytic findings to summarise for this section.

Narrative analysis findings suggest that women who were caregivers for between 1-19 hours a week were more likely to attend mammography. Women with a GP who is female, has a positive attitude or graduated more than ten years ago were more likely to attend BCS. Women living in rural settings or invited to mobile clinics were more likely to attend screening. Interventions had variable effects on attendance at mammography.

3.5.4 Summary of predictors

To summarise, the following figure presents all the predictors of BCS uptake that have been discussed in this review grouped into demographic, health or other factors.

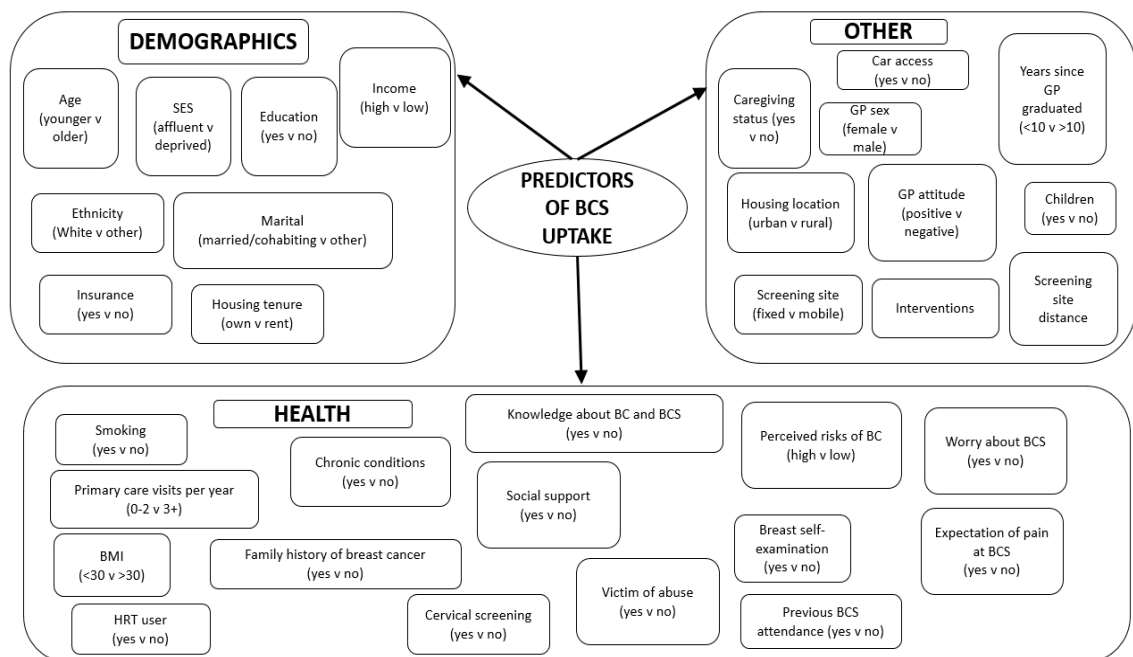


Figure 44. Predictors of BCS uptake in the review

Table 8 and Figure 45 summarises results of all meta-analyses, located on the next page.

Table 7 A summary of meta-analysed odd ratio comparisons

<u>Predictor</u>	<u>Number of studies included</u>	<u>OR</u>	<u>Favoured group to attend BCS</u>
Marital Status (Married or cohabiting v other)	17	1.60 (1.38, 1.85)	Married
Smoking status (Ever smoker v never smoker)	3	0.62 (0.45, 0.86)	Never smoker
Chronic conditions (yes v none)	8	0.70 (0.61, 0.81)	No chronic conditions
Primary care visits (3+ vs 0-2)	3	1.73 (1.6, 2.84)	3+ visits
Ethnicity (White v Other)	4	1.09 (0.83, 1.42)	No significant difference
BMI (obese v non-obese)	3	0.86 (0.71, 1.05)	No significant difference

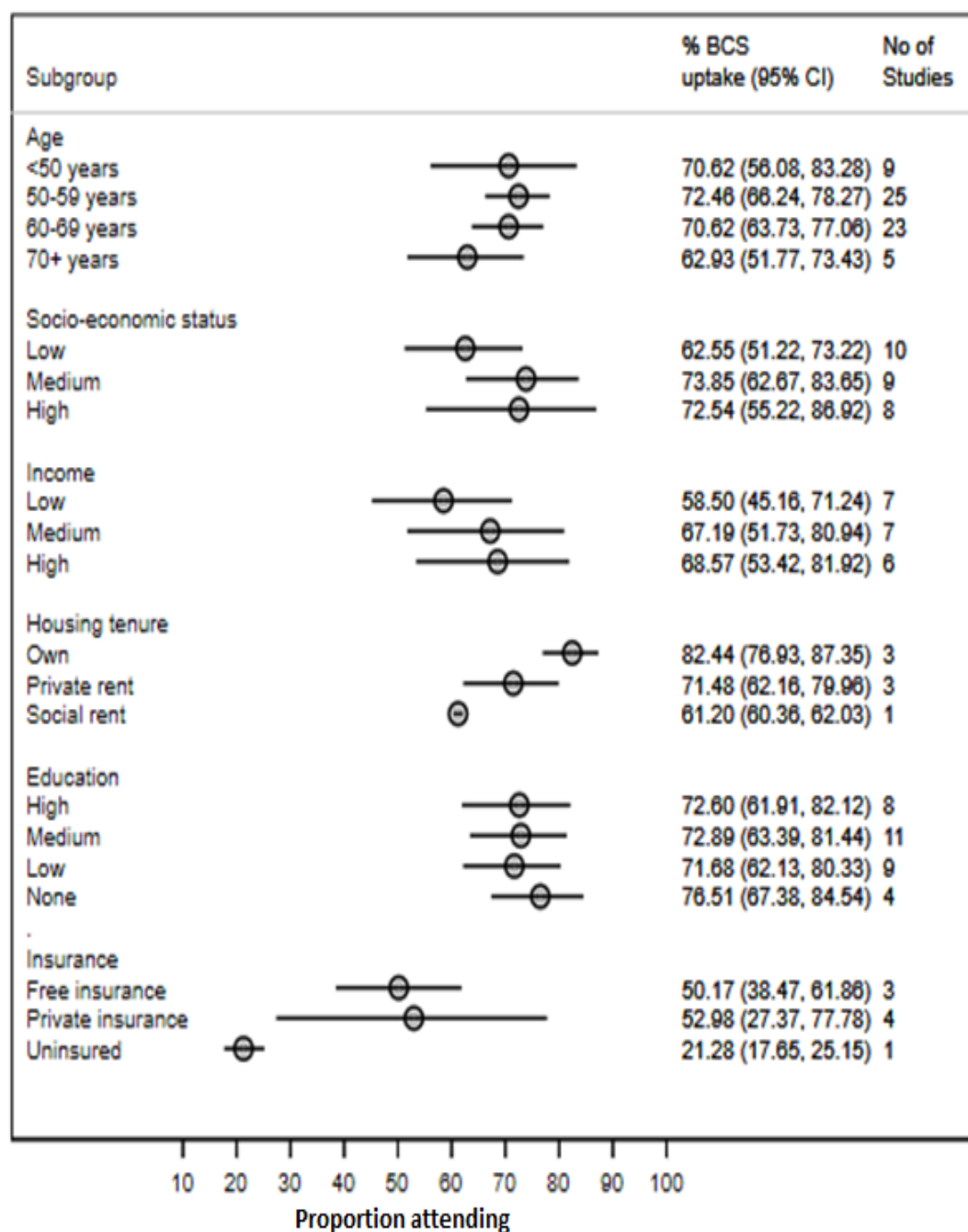


Figure 45. Summary of the sub-group meta-analyses conducted in Stata. The proportion attending mammography for each group are provided in one figure for reference and comparability.

Below is a summary of the extracted, non-meta-analysed predictors only.

Table 8. Summary of the lowest and highest reported uptake rates for each predictor. This data does not include re-screening data.

Predictor	Lowest attendance reported (%) (ref)	Highest attendance reported (%) (ref)	Comments
Demographics (none to report)			
Health			
Hormone replacement therapy			
Ever used	85.8 (141)	94.3 (309)	A mixed effect of HRT on uptake was found. Studies were conducted in disparate settings.
Never used	84.25	88.5	
Family history			
No	68.6 (268)	NA	The effects of family history on uptake were variable
Yes	31.3 (168)	85.0 (306)	
Cervical screening			
Yes	73.2 (289)	92.6 (308)	Previous attendance at cervical screening appears to be associated with the uptake of mammography
No	23.3	75.5 (171)	
Breast self-examination			
Yes	45.1 (125)	62.0 (125)	Breast self-examination appears to be associated with the uptake of mammography.
No	7	44.5	
Victim of abuse			
Any	N/A	53.8 (270)	Only Gandhi <i>et al.</i> (270) reported data on victims of abuse and uptake of BCS. Of women who experienced intimate partner violence, victims were more likely to be up-to-date with mammogram screening.
No		34.5	

Predictor	Lowest attendance reported (%) (ref)	Highest attendance reported (%) (ref)	Comments
Knowledge about BCS Yes No	56.5 (121) -	78.1 (306) 28.6 (121)	Freitas <i>et al.</i> (121) used data from Portugal whereas Rodriguez <i>et al.</i> (306) used Spanish data. Both countries screen every two years from 45 years of age. Rodriguez <i>et al.</i> only provided information about women with knowledge.
Perceived risks (of breast cancer) Low(er) Other	23 (125) 45.8	51.5 (125) 66.6	Uptake appears higher in women who knew the role of BCS.
Expectation of pain Yes No	N/A	50.6 65.0	Of women who expected BCS to be painful, uptake was lower.
Other			
Car access Yes No	37.7 (278) 30.0	80.3 (300) 60.1	Uptake was higher for women who had access to a car
Children Yes No	7.6 (75) 10.3 (158)	44.8 (158) 17.6 (75)	The effect of having children on uptake of mammography appears variable
Housing location Urban Rural	31.1 (168) 37.3	74 (286) 80.3 (300)	The majority of studies found uptake was higher in women living in rural settings.
Distance to screening site Close Far	12.1 (276) 3.4 (279)	57.2 (279) 16.0 (278)	Uptake was higher in women who lived closer to the screening site

Predictor	Lowest attendance reported (%) (ref)	Highest attendance reported (%) (ref)	Comments
Type of screening site Fixed Mobile	15.3 (141) 13.52	73.2 (297) 77.1	Uptake was higher in women who attended a mobile screening site
Caregiving status Yes No	N/A	77.1 74.4	The odds of attending were higher for women who were caregivers.
Physician sex Female Male	35.8 (293) 30.5	82.0 (279) 80.8	Uptake was higher for women who had a female physician
Physician attitude to breast screening Positive Negative	N/A	82.0 (279) 82.0	Uptake was higher for women who had a physician with a positive attitude to BCS
Years since physician graduated <10yrs >10yrs	N/A	24.3 (287) 25.6	Uptake was higher for women whose physician graduated over ten years ago.

3.5.5 Sensitivity analyses

Due to the large amount of heterogeneity in the meta-analyses, sensitivity analyses were conducted. The predictor age was used to base sensitivity analyses on as it had the largest number of studies included and also allowed the greatest number of sensitivity analyses.

Firstly, sensitivity analysis was conducted based on year the data were published (pre- or post-2000) as the UK screening programme changed significantly during 2000; the programme was expanded to include women aged 65-70 years and it introduced the use of two views to all screens (336). Heterogeneity remained high at $I^2 > 98.0\%$. Compared with the combined meta-analysis, the sensitivity analysis using only data published before 2000 changed the pooled attendance rates as can be seen in *Table 10* below.

There were only three studies in the oldest age group post-2000 analysis which all had high attendance across all ages. It is therefore difficult to identify if the observed effect of age is due to a real-life difference in age groups or simply a difference between the included studies. However, two of the included studies did show a lower attendance in this older age group relative to their younger age groups so it is likely that this effect is still a problem.

Table 9. Sensitivity analyses age meta-analysis data by year published.

Age group	Meta-analysis	Pre-2000 sensitivity analysis	Post-2000 sensitivity analysis
<50 years	0.79 (0.75, 0.83)	0.87 (0.87, 0.88)	0.75 (0.69, 0.80)
50-59 years	0.75 (0.68, 0.81)	0.79 (0.65, 0.90)	0.72 (0.64, 0.79)
60-69 years	0.71 (0.64, 0.78)	0.76 (0.66, 0.85)	0.70 (0.61, 0.78)
70+ years	0.63 (0.47, 0.78)	0.36 (0.35, 0.37)	0.77 (0.67, 0.86)

Subsequently, only studies that scored 'strong' on the QAT assessment were included but heterogeneity values remained consistently high. Thirdly, a further subgroup meta-analysis was conducted using geographical location within the age data. The heterogeneity consistently remained high at $I^2 > 90.0\%$. There were some differences

between pooled attendance rates at different geographical locations as shown in *Table 11*.

Table 10. Sensitivity analyses age meta-analysis data using geographical location.

Age group	Combined meta-analysis	EU (excluding UK)	USA and Canada	UK
<50 years	0.79 (0.75, 0.83)	0.86 (0.83, 0.89)	0.48 (0.26, 0.70)	0.77 (0.65, 0.86)
50-59 years	0.75 (0.68, 0.81)	0.81 (0.76, 0.85)	0.54 (0.38, 0.71)	0.78 (0.71, 0.84)
60-69 years	0.71 (0.64, 0.78)	0.77 (0.71, 0.84)	0.57 (0.37, 0.77)	0.73 (0.68, 0.77)
70+ years	0.63 (0.47, 0.78)	0.68 (0.40, 0.91)	0.57 (0.40, 0.74)	No data

Finally, sub-group analyses were conducted using only data that did not sum attendees or non-attendees to 100% and another using only data that did not include re-attendance.

Removing any particular group of studies did not result in a reduction of heterogeneity to any desirable level. These analyses are shown graphically in Appendix 8.1.7.

3.6 Discussion

This study has reviewed the current evidence about predictors of breast screening uptake using worldwide data. It has collected and collated information in order to provide an overarching summary of associations with BCS attendance.

Fundamentally these studies are very heterogeneous and cannot always be reliably combined in analysis. Despite this it remains important to attempt to identify predictors of BCS uptake.

Data were obtained from studies published within a twenty-nine year timeframe from 1987 to 2016. There are likely to be different rates of uptake from these different time periods due to changing social pressures and screening programme guidelines.

Data were collected from a wide range of countries including USA, UK, Korea, Israel, Spain. The sample was heavily influenced by studies coming from the UK and USA (43.7% of included papers) with minimal input from non-western countries (7.8% of included papers). Healthcare practices vary widely from free at point of care to insurance-based policies. Nonetheless, data were pooled to obtain an overall estimate of the predictor and its association with uptake.

It must be noted that the majority of data (61% of included papers) came from retrospective cohort studies. To increase accuracy and reliability, papers that used self-report data for uptake were excluded. However, some studies will have used self-report data in terms of SES and ethnicity and this should be considered when interpreting the results.

SES is defined as the social position or class of an individual or group, in this instance it is used to measure which group a woman is thought to belong. SES is often measured as a combination of education, income, occupation and/or access to resources (337). Each of these individually has its own strengths and limitations but in combination they are thought to provide a reasonable assessment of one's material situation (338). The advantage of using this type of analysis is that the information is often readily available and easy to analyse (338). Someone may be classified as 'poor' if they are rated low on any scale of SES measurement. Furthermore there are some key limitations with how SES is often measured. For instance, in the UK a woman's SES was measured by the occupation of the male earner in the household until 2000, despite who had the more advanced job or income (338).

Of note here is the dissimilarity of reporting of SES between studies. Some reported SES as high, medium or low. Other papers reported SES in quintiles. O'Byrne *et al.* used the 'socioeconomic index for areas' from Australia, of which the two most affluent groups were merged (141). If data could not be merged into three distinct groups as described, they were not analysed quantitatively in this review. SES data as proxy of occupation, community income or education were analysed narratively as reported Appendix 8.1.5.

3.6.1 Do my results agree with other studies?

3.6.1.1 Demographics

The included papers reported age categories differently. Consequently, I combined data into four age groups that allowed the maximum amount of data to be used. The meta-analysed age data showed non-significant differences. However, conclusions are difficult as the effect of age may be lessened as age increases masking effects such as media exposure and changing social attitudes (cohort effects, discussed more in chapter 5 below) and previous experience as women are re-invited for screening every three years in the UK but more frequently elsewhere (339). This finding for age is contrary to the hypothesised outcome found in previous literature and an important issue for future research, to understand whether particular age groups of the population have different attendance patterns and this will be investigated in more detail in Chapter 5 on predictors of attendance at a London, UK breast screening centre.

My meta-analytic findings indicated there was no significant difference in attendance between women of different SES groups. This is not consistent with previous literature which indicates that more affluent women are more likely to attend screening (79, 133, 135, 340).

Results of this review also demonstrate that women with low income are no less likely to attend screening than women of higher incomes. It is, again, a surprising finding because it is logical that in countries where attendance requires out-of-pocket expense, income may be closely associated and/or influence uptake. We may need to take into account that women with high income may be able to afford private screening, and this information would unlikely be included in this review.

Again, a consequence of analysing data from a heterogeneous sample of countries means that high income in one country may not equate to the same level of income in another country. Being considered 'poor' in the USA is likely very different from being 'poor' in Sweden. Additionally, each country has its own protocol of how women can access screening programmes and therefore material deprivation may affect uptake behaviour differently across programmes making it hard to analyse and summarise.

Again, this review found no significant difference between White women and women of other ethnicities, OR 1.09 (0.83, 1.42). Previous literature has indicated a lower BCS uptake among women of minority-ethnic backgrounds (122, 137). This is investigated further in Chapter 5. The pooling of this data is a cause of concern, the ethnic minority in one country may be the ethnic majority in another and thus countering each effect. Analysis without the study from North Korea was conducted in order to assess for this effect due to its large sample size of over a million women but no observable difference was found.

Lower educational background has previously been associated with lower uptake of BCS (127, 341) which is not consistent with results of this review. Surprisingly, this review found the highest rates of attendance averaged 75% (67, 84%) for women with no education. However a meta-analysis conducted in 2015 on papers published between 2000 and 2013 found the odds of attending were 61% higher for women with higher education compared with lower education, OR 1.61 (1.36-1.91), $p < 0.0001$ (127). Despite this, Anagnostopoulos *et al.* acknowledge that the differences in the literature about the influence of education on mammography could be accounted for by the type of BCS programme such as national or opportunistic (342).

Previous research has found that attendance at BCS was higher in women who were single, divorced or widowed compared with women who were married or cohabiting (128, 129, 278). My results do not support this, consistent with other research which suggests being married is a predictor of attendance (116, 125, 154, 169, 343). The difference in findings could be due to a confounding factor such as social support which has been associated with uptake separately (280). Simply because a woman is married does not ensure she has more support than a woman who is not married.

Women who were insured were significantly more likely to attend BCS than those who were uninsured. This is consistent with the anticipated hypothesis as in countries with national screening programmes that incur an out-of-pocket expense it is somewhat unlikely that low income women would attend unless they had insurance to cover the expense.

Women who owned their property were found to be more likely to attend BCS than women who socially rented their housing. This may be interlinked with SES, location in relation to screening site accessibility site distance and location or other factors such as car access. It could also be the case that women who rent their home are likely to move house more frequently and consequently may not register with health services or receive invitations to screening. This was suggested previously as an explanation for lower attendances in cities with transient populations (139, 154).

3.6.1.2 Health

Attendance of women defined as obese ($BMI \geq 30$) was not significantly different from women who were not obese, OR 0.86 (0.71, 1.05). This is not consistent with work conducted by Damiani *et al.* who found that obese women in Italy (as measured using BMI) were less likely to attend BCS compared to women who are not obese, OR 0.87 (0.77, 0.98) (2dp) (124).

There are multiple factors that influence a decision within the realms of 'psychosocial' determinants. Women in this review who perceived their BC risk to be lower than average were associated with lower uptake of BCS. This is concordant with previous research on this topic by Drossaert *et al.* (152) which highlighted 'perceived threat' as important in the HBM for screening decisions (112).

'Expectation of pain' was only reported as a predictor of uptake from one study. Uptake was found to be higher in women who did not expect pain (125). This is consistent with previous literature suggesting pain expectation or previous experience of pain is a deterrent to participation (98, 181).

It is difficult to ascertain what may be happening in the case of the predictor 'knowledge'. It is likely a factor that influences each woman differently depending on other interacting predictors. For instance, for some women, understanding the risks and limitations may be preventing attendance at BCS. Equally, for others who understand the risks and limitations they may still attend BCS for different reasons.

Smoking appears to be associated with women's attendance at BCS. My meta-analysis estimates that women who have ever smoked are less likely to attend screening than women who never smoked. This is consistent with results from

previous survey data that found smoking was associated with a decreased probability of attendance (344).

Previously, research has found women with a current prescription for HRT are more likely to attend BCS (133). Reported uptakes of this review also estimate attendance is higher in women who have ever used HRT. This could potentially be linked to a confounding factor as the number of contacts made with a healthcare professional as an increased number of primary care visits was statistically found to be a predictor of uptake in the meta-analysis. However, further research is warranted to confirm or refute this hypothesis.

The healthiest women are generally found to be those with highest attendance at BCS (77). This review has not demonstrated this as women with 3+ primary care visits have higher attendance compared with women with 0-2 visits. There was no reported data on the reasons why women had attended primary care and so the data may not accurately differentiate between healthy patients and non-healthy patients and so conclusions from this are to be interpreted tentatively.

A more accurate representation of this information may be in that analysed as 'chronic conditions', where women were categorised based on the number of chronic conditions, defined as those that "regularly affect daily living". The review found that for women with no chronic disease they were 30% less likely to attend BCS than those with a chronic disease, OR 0.70 (0.61, 0.81). This is supportive of research conducted by Selvin *et al.* who reported a similar effect size, OR 0.72 (0.53, 0.98) $p < 0.05$, for women with self-reported health status as excellent/very good/good compared with those who reported their health as fair/poor (344). Again, these women who have chronic disease(s) were likely have more frequent contact with healthcare professionals and perhaps therefore have a better understanding of the BCS programme or have more opportunity to discuss their attendance. For women who had mental health related conditions, results appear to show uptake rates are lower, ranging between 30.6% and 50.8%, compared with the reference population of non-serious mental health patients (322, 324). Uptake of BCS was lower in hospitalised women also.

As with other predictors, the influence of family history of BC on uptake of BCS is difficult to estimate. Previous research has found conflicting outcomes with both increased and decreased uptake (119). In this review, reported uptake was higher in women with a family history of BC.

Previous attendance has been strongly associated with future attendance (150). This review found women who have previously attended BCS were more likely to attend subsequent rounds.

Women who practice BSE at least once a month were found to be attending BCS more frequently than those that do not, consistent with previous literature (77, 125, 171, 306, 345). This may be for a variety of reasons including worry or conforming to societal 'rules' of attending preventative services.

Consistent with previous research (77), this study found women with previous cervical screening history were more likely to attend BCS than those without a screening history (171). In the analysis of a nation survey in 1998 conducted by Selvin *et al.*, having a usual source of care was the most important factor underlying uptake of both breast and cervical screening invites (344).

Despite mounting evidence suggesting IPV has long-lasting negative effects on the health of the victim (346), this review found that women who were victims of abuse were more likely to attend BCS than women without any abuse experience. However, there is insufficient data in this review to conclude how such an association may be influencing uptake and further research is warranted.

3.6.1.3 Other

In this review the findings were variable as to whether women with children were more commonly found to be higher attenders at BCS than women without children. This is not consistent with the anticipated findings as previous research has cited childcare as a barrier to attendance (75, 347-349).

No meta-analytical assessment was made on housing location. However, from the narrative summary of included studies it can be observed that higher reported uptakes were found in women living in rural locations. Perhaps this is due to a fundamental difference between women who live in urban and rural settings which

cannot be accounted for in this review. It is important to note the heterogeneity of locations the data were sampled from – living in a rural setting in Canada or Australia is very different to living in a rural setting in the UK, and this needs to be considered in interpretation of the results.

Car access appears to be associated with BCS uptake. Uptake of BCS was higher in women with access to a car. This is also likely due to a combination of other confounding factors. Women with car access are more likely to be affluent members of the population (138) which was associated with higher attendance in previous literature but not in my review (133). Additionally, women with access to a car are less likely to have logistical barriers in travelling to the screening site.

Distance to screening site is known to be an influencing factor in the uptake of mammography, with uptake often being lower in women who have larger distances to travel (138, 163). In this review, women who lived 'close' to the screening site were more likely to attend BCS. However, from data included in this review, the type of screening site does not appear to be associated with uptake.

The extracted data suggests the GP is a predictor of attendance at BCS. In line with expectations, results suggest women with a female physician are less likely to attend than those with a male. Only one paper reported the influence of GP attitude on uptake and those with a positive attitude had higher rates of uptake. Associations between GP attitude and BCS attendance are not always found to be significant in previous work (350). Reported data estimates women under the care of a GP who graduated fewer than ten years ago were slightly less likely to attend. This is perhaps reflective of more up-to-date understanding of evidence-based practice. Again, only one paper included in this review reported on this predictor (287).

The anticipated hypothesis was to find lower uptake in women who were considered to be caregivers due to preventative barriers such as time, money or worry (351). This review found that uptake was higher for women who are caregivers' than those who are not caregivers. This finding was contrary to the hypothesis and could be because I combined any amount of caregiving into one category and analysed carer

versus non-carer rather than non-carer, part-time carer and full-time carer. However, there was insufficient data available to answer that more specific question.

The results of this review suggest interventions have increased uptake. In the USA, women receiving a letter endorsed by a physician showed higher uptake rates compared to women receiving no endorsement; the same was observed in Italy (43, 144). Furthermore, this review found interventions of simple reminders were shown to increase likelihood of attendance (314). This is consistent with previous research suggesting reminders improve uptake (161). However, the type of reminder and other factors such as method of reminder and distance to screening site appear to have impact. Similarly, women who received tailored invitations to BCS were more likely to attend than those who did not (84, 124). Another intervention that has produced increased uptake at BCS include invites with the option of an out of office hours appointment. Uptake for women receiving this invite was 76.4% compared with 69.1% for women who did not have this option (297).

3.6.1.4 Summary

The meta-analysis had some unexpected results. It was hypothesised that women who were older, of minority ethnicity, had a lower income or were less affluent, lower educated or lived in rental accommodation would be found to be less likely to attend. However, the review found non-significant results for these factors. This is perhaps due to the heterogeneity of the screening programmes or between women invited to screening programmes in different countries. However, it is an important finding that influencers of uptake are likely to differ across programmes.

Surprising findings among the narrative analysis include an increased uptake in women who live in rural settings. However, study settings are so diverse this needs further investigation. Secondly, increased uptake was observed in women who were reported as care-givers contrary to expectation. It could be due to a mis-categorisation of the caregiving hours which may hide a true effect. More research is required to investigate this phenomenon fully.

It was unfortunate that there were not sufficient articles with comparable data to quantitatively analyse all predictors. However, of those that are comparable it is

interesting to note that not all predictors found similar results across the meta-analysis and the narrative review. For instance, there was no difference found quantitatively for SES whereas narratively affluence was associated with increased uptake. This could be due to the definition of SES used in each study. Being married was associated with increased uptake in all analyses and similar results were found across ethnicity and age. The meta-analysis found different results to the narrative analysis for co-morbidities and chronic health conditions. However, this could be due to the severity or variety of health conditions analysed and the definitions were slightly different from the outset (number of co-morbidities compared with 0-3 or 3+ chronic conditions).

3.6.2 Comparison with other reviews

In this section I compare the findings of other systematic reviews with my findings.

A review conducted in a UK setting which investigated BCS uptake in Black women found the perceived risk of BC and perceived importance of BCS was variable amongst Black women. In particular, Black women gave quotes about BC being “a Caucasian disease” despite known family history connections and the review also suggested a general understanding of breast health was negligible in the population studied (352). A significant knowledge deficit may underpin some stigma of BCS for Black women. Spirituality and religion were also found to be of relative importance in the influence of Black women’s BCS behaviour (352). My review found knowledge about screening is to be associated with uptake so a link between a lack of knowledge, particularly in minority communities, and uptake appears feasible and consistent with my results interpreted above.

Another review found South Asian (SA) immigrants regularly have low BCS uptake despite their risk increasing post-migration to that of the non-Asian native population (248). Some SA participants included in this qualitative review had low perceived risk of BC and again, some women believed BC was a “White person disease” (353). A lack of knowledge was evident here as some women were stating a lack of symptoms was their reason for not requiring BCS. Language was consistently quoted and loss of social support upon immigration was cited as other barriers to uptake; this aligns with the results of my review.

As with all the evidence included in my review, common barriers such as time, money, children, work and transport were cited as reducing the likelihood of attending BCS. This supports evidence provided above that these factors are associated with uptake. However these reviews have highlighted that particular subgroups may be affected by predictors in different ways than others in this complicated network of predictors (352, 353).

A review conducted by Damiani *et al.* found a positive association between level of education and adherence to mammography guidelines (127). It found evidence that higher educated women have a greater awareness about their risk of BC, tend to have more interest in health issues and have better access to resources for health improvement. This is likely mediated by their SES and their level of health literacy as defined as *capacity to “obtain, process and understand basic health information and services needed to make appropriate health decisions” [p. 286] (127)*. The major limitation, and consequently how I found different results, was that it relied on self-report data which, as discussed above, is unreliable and were not included in my own review.

Despite guidelines and national protocols for participation targets for BCS, there are subgroups that are still underrepresented in mammography uptake. The one group of variables that is consistently associated with increased participation in mammography is participation in other preventative healthcare practices such as cervical screening (78).

3.6.3 Implications

Each decision to attend BCS or not includes the complex network of factors mentioned above. The influencing factors analysed in this review have been summarised below in Figure 46.

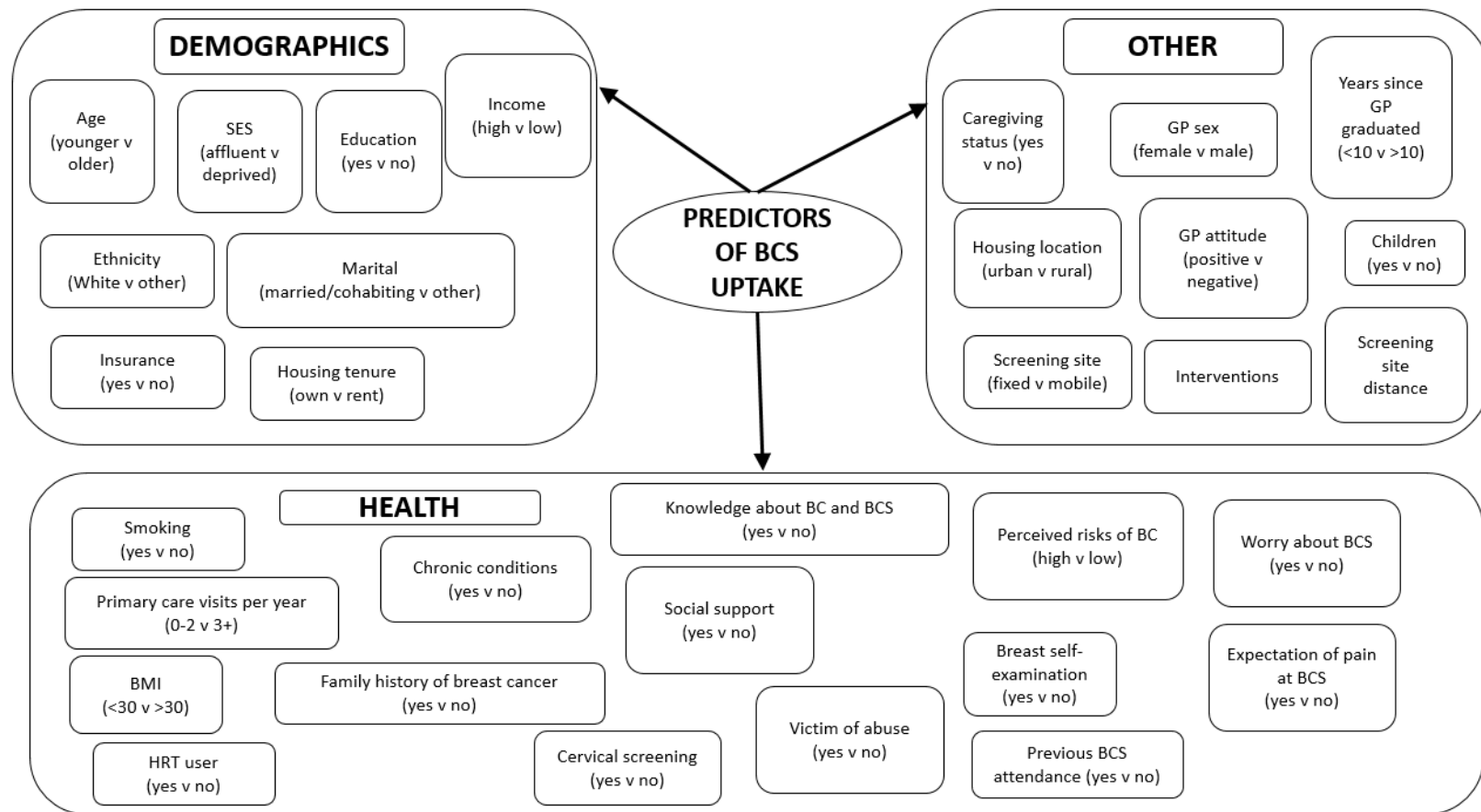


Figure 46. Summary of predictors of BCS uptake investigated in this review

To summarise the meta-analytic findings, women who are married or cohabiting, never smokers, have no chronic conditions, have three or more primary care visits annually are more likely to attend BCS. Women living in socially rented housing were found to be less likely to attend screening than women who owned their house or rented housing privately. Women who were uninsured were significantly less likely to attend compared with women with insurance. Ethnicity and BMI were not found to be statistically associated with mammography attendance. Sub-group analysis found no significant difference between women of different ages, SES, income or education.

Narratively, reported uptake was higher in women who used HRT, had access to a car, had children, lived in rural locations, lived close to the screening site, had family history of BC, had attended cervical screening, conducted BSE, had higher perceived risks of BC, had no expectation of pain, were caregivers, had knowledge about BCS, were victims of abuse, had a female physician or who had graduated more than ten years ago. No difference in reported uptake was found between types of screening site or between women under the care of a physician with a positive or negative attitude.

To the best of my knowledge this review is the only one which encompasses exploration of all possible predictors of uptake worldwide. Whilst it was important to investigate worldwide predictors of uptake to minimise bias, update the literature, obtain a holistic and wholesome view of predictors of uptake and to establish what needs to be researched further, it was surprising to find no significant difference between uptake of women of different ages, affluence or ethnicities. This was perhaps due to the comprehensive scale of the review and that any significant findings were countered in opposing countries. It is important to investigate this further using individual countries and/or studies as sub-group analyses.

This review has shown that there are many different factors influencing attendance and uptake of BCS. Perhaps the NHS should adapt its screening service to include some of the information obtained by this review. For instance, providing sensitive material alongside the invite letter to women who have either bad experiences at previous appointments or logistical barriers prohibiting them from currently attending may encourage more openness and support towards BCS from these women and their families.

Moreover, policies involved in dealing with a woman with a false positive result or a previous false positive experience need looking at in detail in order to minimise anxiety or worry and enhance re-attendance (99). There appears to be a lack of research investigating how and why false positive results affect uptake. Future research could be conducted using a more exploratory approach to consider how and why the false positives affect BCS uptake.

Sex of GP was found to be associated with the uptake of BCS. Re-training GP's and healthcare professionals may improve knowledge transition between professionals and patients, subsequently increasing IC on uptake. Besides printed literature, providing opportunity for women to discuss their BCS decision with a GP or nurse may encourage IC and perhaps even increase uptake.

Further research needs to investigate the effect of the perplexing results above. For instance, this review found caregivers were more likely to attend screening compared with women who are not caregivers which was not anticipated from the background literature. In-depth reviews investigating predictors such as these using a worldwide view could be useful to see if the overall effect masks differences in some countries.

Secondary data analysis of this research further investigates some key predictors of uptake using a UK urban sample of the population. Questions that remain unsolved include 'have differences in attendance always been the case or have these inequalities increased over time?' The same can be asked of ethnicity, age and SES differences in uptake.

Another future development this review supports is the need for tailored information and invitations. Every woman is affected by different influencing factors in her decision whether or not to attend screening, which has been pointed to already. In particular, it appears important that tailored information spans a wide range of factors including ethnicity, education, false positive experiences and personalised risks and psychosocial factors. How realistic this would be for the NHS is a matter for further research. The questionnaire that I am developing as part of this thesis will explore how personal risk of BC and IC influence uptake. It would be unfeasible to further develop this idea within this PhD. However, it is possible to use the results of this doctoral research to ground future research to investigate how this may be incorporated into the patient information and invitation literature.

3.6.4 Heterogeneity

Variance of methodological, statistical or clinical origin will exist when combining data in a meta-analysis. Throughout this meta-analysis there was significant heterogeneity with I^2 values between sixty-eight and ninety percent meaning a high proportion of the variation across studies was due to heterogeneity rather than chance. Whilst some of this was anticipated due to the large sample sizes and accuracy yet disparity of many of the included studies used, it has provided some concern for the analysis and interpretation of the data.

The statistical heterogeneity may have been caused by clinical differences between the study types, for instance pooling of RCT data with cohort data or unknown study characteristics.

The I^2 value has not taken into account the clinical heterogeneity that must be present in this analysis. Studies have been combined from twenty different countries which have distinct screening programmes and guidelines.

3.6.5 Pooling of data

A major advantage of pooling the quantitative data obtained is that it allows a summary estimate of the overall effect of predictors associated with the uptake of BCS. It is argued that pooled data analysis has the maximum reliability as it provides a holistic framework and allows the presentation of data in respect to all available knowledge. The pooled data provided a larger sample size on which to conduct analyses and subsequently enhanced statistical power to detect statistical differences between subgroups.

The main source of uncertainty whether this was the correct approach is that considerable heterogeneity is present, discussed above. The pooled data may become meaningless if heterogeneity is too large. To help overcome some of the methodological flaw in pooling data, random-effects modelling was utilised to account for both between-study and within-study variability. By pooling data one combines information of different quality which may bias the result.

3.6.6 Different methods

As mentioned previously, meta-regression as an extension of the subgroup analysis or a Bayesian approach to the data would have been preferable, if the data were sufficient. However, this was impossible due to the type of data we had. Some data provided prevalence estimates by different subgroups but did not have crude or adjusted association measures

such as odds ratios. Additionally, a meta-regression would need many more studies where each reported its results split by various subgroups of interest.

A major limitation of the meta-analysis is that the study effects are not accounted for, for instance there is no account for the similarity of age group one in study A to age group two in study A. They are currently treated as if they came from separate studies. To account for this a two level mixed-effects model for dichotomised outcome (attended or not attended) was conducted with the study being a separate level. Odd ratio results suggest the odds of attending were 14% higher for women aged 50-59 compared with women under fifty years, OR 1.14 (1.12, 1.15); 8% higher for women aged 60-69 years compared with women under fifty, OR 1.08 (1.06, 1.10); and 31% lower for women aged over seventy compared with women under fifty, OR 0.69 (0.67, 0.70), $p < 0.001$.

For future research, the same analyses could be conducted on all predictors reported to influence uptake of mammography to provide an overall odds ratio estimate of its association with BCS.

3.7 Strengths and limitations of the review

The four 'weak' papers remain in the quantitative analysis and this is a limitation of the review. However, the majority of the data came from 'strong' rated articles. In hindsight it would perhaps have made more methodological sense to remove these four papers from the analyses and is often suggested in the literature however, the concern about this approach is that it could remove and exclude studies that provide valid information (354). Another approach, in hindsight, may have been to assign a weighting to the study according to its quality assessment score although this has methodological flaws too (354). However, a sensitivity analysis with and without the 'weak' papers found no significant difference in the results and therefore I can be confident in the analyse conducted.

Having published the protocol prior to commencing the review improves the reproducibility and transparency of the research and researcher involved. This has safeguarded against subjective inclusions and against the selective reporting of findings (355). This public record has also encouraged compliance with PRISMA reporting statements (356).

A search strategy was written and developed that searched a wide platform of potential literature databases to include as much data as possible from a worldwide perspective. It has

been discussed that using terminology to confine the search further at this initial search strategy would be counter-productive. Restricting the search would return insufficient relevant material and narrowing of the results would miss a large proportion of the pertinent literature. Instead, stringent inclusion criteria were used. The vast, varied breadth of studies is an important advantage of this review as a large body of evidence was searched, sifted and included. The large sample (n=91) in this review increased statistical power within the meta-analysis and allowed a narrower confidence interval for the final results (357). Conversely by using such a large sample and having sufficient data to test multiple hypotheses, it may have inadvertently introduced type one bias. The risk of this was minimised by using the Bonferroni p-value statistic but this possibility still needs to be considered (260).

A study investigating the accuracy of self-report data for mammography claims has shown how unreliable this data is with sensitivity of 93% (90, 95%) and specificity of 54% (49, 59%) (358). Furthermore, this study found a systemic overestimation of uptake when using self-report which could affect any associations drawn from the data and potentially could bias results. It was therefore considered important to exclude self-reported uptake data. In hindsight, perhaps more research to investigate the self-reported uptake data by sensitivity analysis with and without these data would be beneficial to determine if they had any significant effect on the results.

By excluding self-report uptake data it could have influenced which variables appeared most important in the review or even biased which variables appeared altogether (359). Variables such as stress levels, drug use, caffeine consumption and others which are often established using self-reported information would have been interesting to analyse but will unfortunately have been excluded. Most importantly, it is likely that qualitative studies with self-reported attitudes and levels of IC will have been excluded from this review which is a main limitation meaning that results cannot be used to aid the development of the questionnaire in the later study.

Two reviewers were used for all components of the review sifting and data extraction processes which will have increased reliability and decreased bias. Nevertheless, this data only used published sources of evidence which may exaggerate previous positive findings and contribute to any publication bias on the subject.

Quality assessment of the included studies was conducted using a tool that was tested for its construct and inter-rater reliability. Its reliability was also assessed with agreement kappa scores of 0.74 and 0.61 (256). However, currently all evidence is included in the overall analysis and synthesis including studies rated 'weak' in the overall methodological ratings from the QA tool. As mentioned by Juni *et al.* study quality should be incorporated into the analysis and to simply exclude those which are assessed as 'weak' cannot be justified without further elaboration into the methodological techniques they used (354). Of the studies included in this review, 81.6% were assessed to have a 'strong' methodological rating using the QAT, 12.6% 'moderate' and 5.8% 'weak'. It would be interesting to conduct a sensitivity analysis excluding the papers rated 'weak' to assess the impact these papers have on the overall results.

Despite a search strategy to contain worldwide papers in the review, all of those included were from the developed world. This is a significant flaw of the literature as it does not provide a completely encompassing view of BCS uptake. However, this is likely because developing countries have less organised screening programmes and more opportunistic programmes were present which were excluded from the review as part of the exclusion criteria (Appendix 8.1.1).

Due to the nature of this research question, the included papers were extremely heterogeneous. Although expected due to the large sample size and the variation across global BCS programmes, data pooling may not be the most appropriate method. Forest plots and their I^2 statistic for both age and marital status as predictors of uptake clearly show this high level of variation across included studies is due to heterogeneity rather than chance. The associated funnel plots also suggest that some publications may be missing from the review. Meta-regression would have been conducted if the data was more homogeneous. Instead, sub-groups of papers were analysed in different sectors as discussed above, relating to the predictors mentioned and results presented.

Furthermore, data was included from a worldwide vantage point and therefore heterogeneity cannot be overcome. The data came from different studies, countries, time, healthcare systems and cultures so there was vast diversity. However, it was necessary in order to obtain the answer to the research question posed. It has been an important review to establish the predictors of uptake and a variety of studies was necessary to do this work.

Narrative analysis is often considered subjective and less reliable than quantitative methods. However, for this review it was the only available approach as a proportion of the data was unable to be pooled either due to its subgroups or because it provided information about a unique predictor.

Table 12 summarises the advantages and limitations of this review which have been discussed.

Table 11. Summary of the advantages and limitations of this systematic review

<u>Advantages</u>	<u>Limitations</u>
Published protocol <ul style="list-style-type: none"> • PRISMA reporting 	Significant heterogeneity
No self-reported uptake data was used	No papers from the developing world were included
Inclusive search strategy	Multiple hypotheses may have introduced type one bias (attempted to reduce this risk by using Bonferroni p-value statistic)
Two reviewers assessed all stages	Only papers written in English were included
Quality assessment of all included papers was conducted	Second reviewers were not blinded for data extraction
	Narrative analysis is often subjective and less reliable

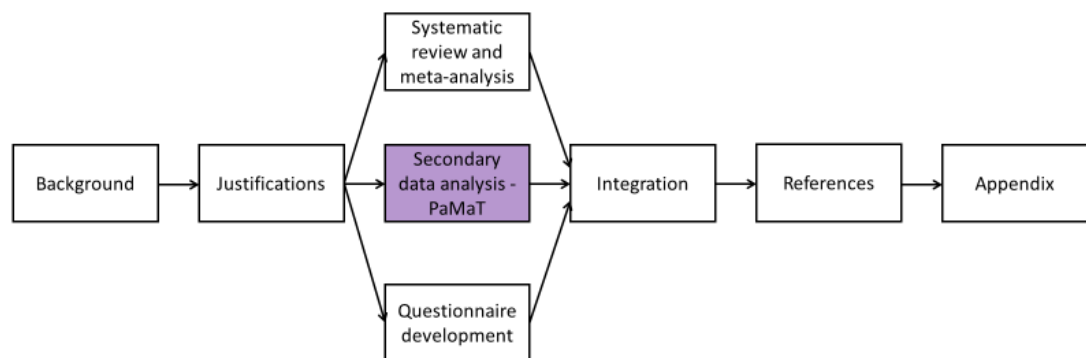
Chapter summary

The purpose of the systematic review was to determine the predictors of breast screening uptake worldwide. Ninety-one studies were included in the systematic review with data analysed quantitatively and narratively.

This review has found many different predictors to be significantly associated with uptake. Predictors found to increase the odds of attending mammography include being married, ever smoked, having no chronic conditions, and visiting primary care three or more times per annum. Being uninsured was found to be negatively associated with attendance at BCS. No significant difference was found for ethnicity, BMI, age, SES, income, housing tenure or education.

My review has found results that are inconsistent with previous literature, perhaps due to the heterogeneity of screening programmes examined. The most surprising results were that ethnicity, age and SES were not found to be significant predictors of attendance. Whilst we do not have a dataset that includes all variables examined in this review, predictors of attendance will be further investigated in the next chapter.

The review has provided evidence about different predictors that will inform the remaining work of the research. For instance, the secondary data analysis will explore in more depth the patterns of attendance in London, UK screening data. It will investigate if these predictors of attendance have changed over time. The questionnaire study will begin the development of a tool that can distinguish different predictors of attendance also.



Chapter 4: Predictors of Mammography attendance over time (PaMaT).

A secondary data analysis

Introduction

In this chapter I will explore predictors of BCS uptake within a South West (SW) London population in greater detail. First, I will demonstrate the methods used. After that I go on to provide quantitative results, both descriptive and analytical. The chapter will conclude by contrasting results with the outcomes of the systematic review described above, exploring the strengths and limitations of the work, and determining the impact of the research.

Context

The data analysed in this chapter come from a cohort in SW London screening centre. Each year approximately 40,000 women attend this SW London centre. Women aged between 47 and 73 and who are registered with a GP in the UK are invited to screening every three years. If women attend they come to a hospital or mobile van in their area for the x-ray of each breast. Women are either given a negative result or asked to return. If asked to return due to a suspicious lesion the screening procedure will be repeated and her results will be assessed by a clinical team to determine if the lesion is cancerous or not. If not, the woman is said to have received a false positive result as detailed later in this chapter.

4.1 Research questions and study aims

The key aim of this study was to ascertain patterns of BCS in a SW London population.

Analysis was conducted on this dataset to answer the research questions:

1. What factors influence uptake of BCS in the SW London population?
2. What factors are associated with uptake of BCS at the first episode in SW London population?
3. Are patterns of attendance changing in the London, UK population?
4. If so, in which specific sub-groups of the population have patterns of attendance changed?

4.2 Study sample

Data between 1987 and 2017 were extracted directly from the National Breast Screening Service (NBSS) software before being anonymised at the SW London site and sent to me securely. Three separate constituent databases were received comprising 406,015 women, 1,283,671 episodes and 1,521,309 appointments respectively. The datasets required linking using key identifier variables (psuedonymised NHS number and/or episode identification number) that remained consistent across three datasets as shown in *Figure 47*. The final database was organised into a hierarchical structure as shown in *Figure 48*. Each woman was invited at least once per screening round (episode) unless she had officially and permanently withdrawn from the screening programme. Within each episode a woman may have multiple appointments due to technical failures or non-attendance as shown in *Figure 48*. The final database used for further analysis used data from 302,690 unique women.

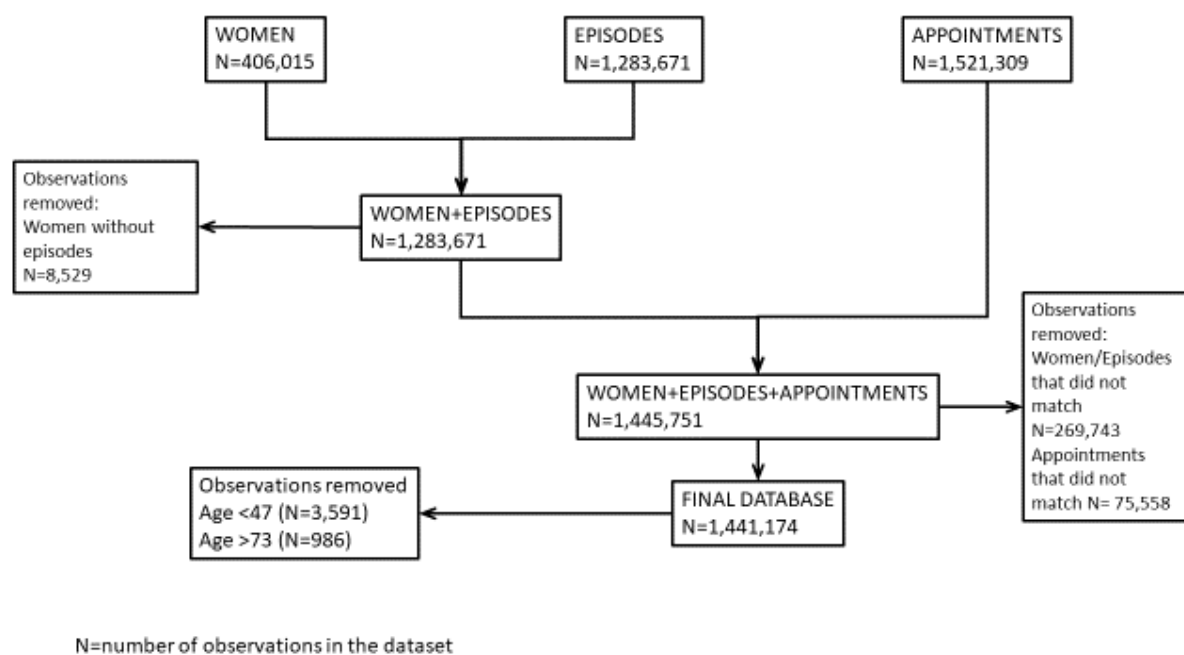


Figure 47. Number of observations at each stage during the assembling of the database from its constituents.

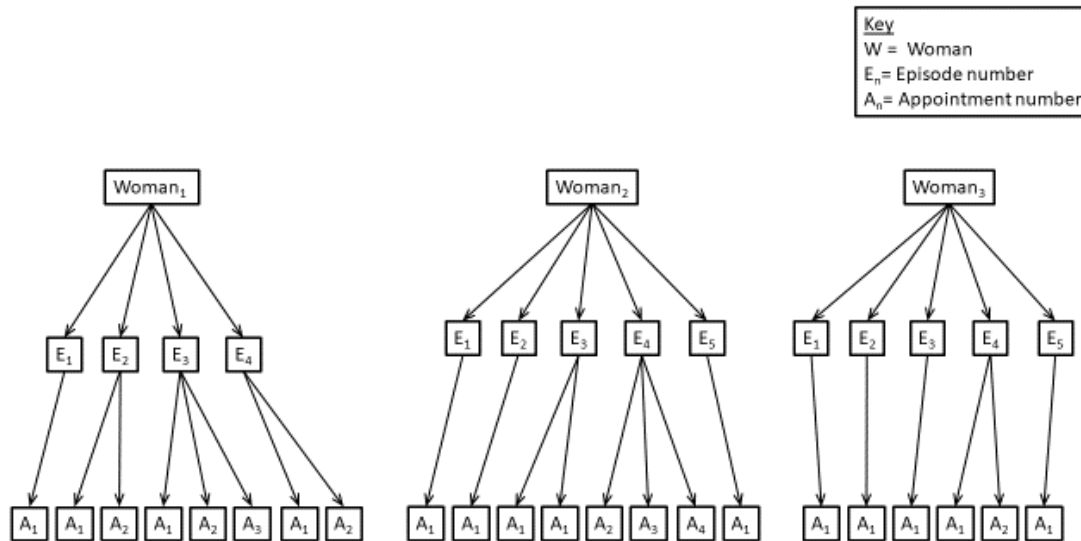


Figure 48. Representation of the database hierarchy.

Appointment data prior to 2000 were removed ($n=345,301$) from the database due to inconsistency of matching of episodes to appointments (Appendix 8.3.5). Sensitivity analyses were conducted on the multilevel models with and without this data and no discernible difference was noted. It is possible these earlier data could be biased e.g. due to changes in data management or changes in methods of data extraction. It was therefore decided to exclude these data from the analysis.

4.3 Methods

4.3.1 Study setting

The secondary data analysis was designed and conducted solely at The University of Warwick. Data from the SW London screening centre were chosen as this centre records ethnicity which was hypothesised to be a key predictor of mammography uptake. As with all secondary research, data were not collected for this study. Instead, data were routinely collected at the time of the mammography appointment by hospital screening staff (who record what happened at each appointment) and using NHS medical record notes. SW London uses the National Breast Screening Service (NBSS) database to record each screening appointment. Each screening centre must submit quality assurance reports to the NHSBSP annually and these are comprised of extractions from this NBSS database. The dataset used for my analysis was an extraction from this NBSS database which ensures the reliability and trustworthiness of the data and means data quality is high.

The London boroughs included in the catchment area for SW London screening service include Croydon, Kingston, Richmond, Sutton and Merton and Wandsworth. These boroughs rank between 91 and 296 (with a rank of one being the most deprived and 32,482 being the least deprived nationally) (360).

4.3.2 Ethical approval

Sponsorship was obtained from BSREC at the University of Warwick. Full HRA approval was obtained on the 16th October 2017. Research and development approval from St Georges Hospital, South West London was obtained on the 17th October 2017 to commence on the 23rd October 2017. Full copies of approval documentation are provided in Appendix 8.3.1.

4.3.3 Obtaining the data

After ethical approval was granted, data were extracted from NBSS database by Rani Nair and Louise Wilkinson using code written by Sue Hudson that linked the woman to their Index of Multiple Deprivation (IMD) decile. IMD allows the measurement of multiple deprivation and identification of need at small area levels. IMD comprises distinct measurement of deprivation separately for income, employment, health and disability, education, skills and training, barriers to housing and services, living environment and crime. IMD combines these to give a single score. It is an area-based measure rather than for an individual – women within any area will not necessarily have the same level of deprivation.

IMD here is represented in deciles. The deciles are calculated by the Government by ranking the 32,844 small area 'boroughs' in England from most deprived to least deprived and separating them into 10 equal groups (360).

All data were anonymised externally before this analysis began.

Table 12. Variables extracted from the NBSS SW-London for use in this analysis

Level	Variable	Description
Episodes	nhscryptic	Unique identifier of each woman in the database. Used to link the databases
	episodeid	Unique identifier of each episode for each woman
	gpcode	The GP the woman is registered at
	ageatfoa	Age at the first offered appointment within an episode. This was the age used for the analyses.
	datefirstappt	Date of the first appointment. This was used to ensure sequential data was correct.
	dateapptmade	Date the first appointment was made. This was used to ensure sequential data was correct.
	episodecharacter	Whether the screen was the first screening or a routine recall
	pistatus	Whether the episode was the incident or prevalent screen
	episodeclosed	Identifies if the screening round is still ongoing for this woman
	episodereason	Reason for episode closure
	attendappt	Identifies if the woman attended the appointment
	episodeendcode	The reason for closure of the episode
	episodeend	The series of events that were undertaken in that episode
	finalactionepisode	Identifies the final action in the episode
	cancerregistry	Identifies if the woman was registered as a cancer patient
Appointments	apptnr	Unique identifier of each appointment for each woman
	screenapptnr	Unique identifier of each screen within an appointment for each woman
	clinic	Clinic code
	dateclinic	Date of the clinic
	timeclinic	Time of the clinic
	apptstatus	Status of the appointment: attended, booked, did not attend and whether notice was given
	canceltype	Reason given for cancellation where appropriate
	bookcanceldate	Date the appointment was booked or cancelled
	notscreened	YES if the woman attended the appointment but was not screened

Level	Variable	Description
	notscreenedcomment	Reason stated
Women	gpcode	GP code
	ethnicity	Ethnicity
	ethnicaid	Old version of ethnicity
	specialappt	Requirement of a special appointment
	specialreason	Reason for requiring a special appointment (such as for disability or breast implants)
	callrecall	Status of the appointment, whether a woman has attended previously
	yob	Year of birth
	isoacode	Code used to identify IMD
	isoaname	Name of region woman lives
	imdrank	IMD rank
	imddecile	IMD decile

4.3.4 Pre-analysis tests

Ethnicity is defined within this study as the self-reported social group the woman feels she most closely belongs and aligns to with the groupings set out in Table 14. Descriptive results maintained these sub-groups, but for the quantitative analysis it was necessary to combine the sub-group ethnicities into the following broader ethnicities: White, Black, Asian, Mixed or Other.

4.3.4.1 Missingness

Six hundred and seventy-three ($n=673/1,445,754$; 0.047%) of the age entries were missing from the age variable with an additional 3,828 (0.26%) ages that were inappropriate (ranging from 12 to 87 years) as they were outside the screening invitation ages of 47 to 73. These were removed from the dataset. Only three entries (0.00021%) had missing date information and therefore were simply removed from the dataset.

Ethnicity had the highest missing data (265,869 women had no ethnicity data which equates to 18.39% of the dataset) but these observations were not removed from the dataset as collecting ethnicity information is a recent phenomenon and missingness was anticipated from the outset.

The first assumption was to test that missing data was missing completely at random (MCAR). This was checked in order to determine the dependence of missing data on the other variables in the dataset in order to decide how to treat the missing data (361). To confirm this trend, logistic regression models were conducted to predict missingness of ethnicity data. It showed that age, requiring a special appointment and IMD were associated with missing ethnicity data. Full results can be found in Appendix 8.3.5.

IMD had 2,467 missing entries which was unexpectedly high. Therefore the association of IMD data being non-missing data was estimated. Similar predictors appeared associated with the likelihood of IMD information being missing.

The majority of missing data (i.e. pre-2000) were MCAR due to a technical fault of the extraction methods. However, for initial analyses with the remaining data I considered groups with missing ethnicity and IMD data as separate sub-categories for each variable in the first analysis as demonstrated by Howell *et al.* before assessing the influence these 'missing' sub-groups had on the dependent variable (362). As no difference in attendance between these and the non-missing groups were identified, it was not fundamentally necessary to use multiple imputation or another statistical technique to generate the missing values. The lack of imputation is a limitation of this research, and there is potential that this may have introduced bias into the analysis (361). I acknowledge that a sensitivity analysis of complete and available cases analysis may be good avenues for further research.

4.3.4.2 Assumption testing

Scatter plots were produced to assess for associations between continuous variables and are provided in Appendix 8.3.6. Subsequently, the result of correlation test between age and IMD was 0.0134 (363). The predictor variables were tested for between-predictor correlations and with the outcome variable (attendance at BCS appointment) using Pearson's correlation tests. The predictors were considered independent from each other. This lack of association was reassuring.

Chi-square tests of association were conducted to test for correlation between non-continuous variables. No correlation was found between special appointments, socioeconomic status and ethnicity as all tests were non-significant.

Another key assumption for linear regression models is the independence of responses. However, this dataset fails this assumption as each woman has multiple observations due to the hierarchy of the data as shown in *Figure 48*. Accordingly, a mixed effects model was fitted to adjust for this.

4.3.5 Multilevel modelling

A mixed-effects logistic model (otherwise known as a multilevel model) was performed for analysis of the binary outcome of attendance (dichotomised to yes or no), using `melogit` command in Stata v15.1. A mixed effects model contains both fixed effects that are estimated directly like standard coefficients and random effects which are those not directly estimated but are summarised from estimated variances and co-variances.

The dataset has a hierarchical structure as repeated measurements are nested within only one individual-level structure, as shown in *Figure 48*. Each woman could have attended multiple mammography appointments within each episode depending on the type of experience she had. For instance, she may have had to re-schedule the first given appointment, then after being screened she was recalled due to a technicality and therefore appears three times in this episode. Furthermore, each woman will reappear in the database every three years unless she opted out of BCS. Therefore, these repeated measures are correlated with each other and are not independent and this is why a nested multilevel model is necessary. Since the outcome used was attendance within an episode, a two-level random-intercept model was used to account for women featuring multiple times within the data. Level one was episode and level two was woman.

The dataset spans seventeen years of screening data. The model was run as both time variant and time invariant to account for predictors that do and do not change over time. Variables at the woman level which were constant over time include ethnicity, IMD, special appointment requirement. The other variables were at the episode level and were more variable.

4.4 Model building and analyses

Once the dataset was cleaned models were fitted to the dataset to answer the research questions.

Level one of the multilevel mixed-effect model contained the episode level data including the dependent variable. The second level incorporated the data at the level of the woman, which did not vary across episodes. All potential variables were included in the initial model but removed if the variable was either not significant or if the subgroups were small enough to result in perfect prediction by Stata.

Variables of potential interest within each model are: age, IMD, special appointment, date, time, ethnicity, being previously recalled, and year (where appropriate). Intraclass correlation coefficients (ICC) were also produced subsequent to each model to determine the level of variance explained by each of these factors.

Whilst building the models, widely accepted statistical tests were used to confirm if specific variables should be entered into the model. Likelihood ratio (LR) tests were used to confirm if there was a significant difference in the nested models with and without certain variables (364, 365). A significant LR test result proved that a more complex model was most appropriate. Akaike's information criterion (AIC) and Bayesian information criterion (BIC) were also considered when non-nested models were compared (365).

This method was also adopted for exploring possible interactions. Any interaction effects that perfectly predicted the attendance outcome were dropped automatically by Stata. The following interactions were removed by Stata due to high collinearity: ethnicity with IMD, requiring a special appointment with IMD, ethnicity or age and previous recall with age. This was likely due to small numbers within subgroups, particularly for those requiring special appointment which was only 17,878 episodes. The only interaction that remained in any model was that between age and IMD. Nonetheless, upon testing of the nested models using LR tests as above, the model without the interaction effect was preferred. The effects of removing the interactions from the model will be discussed later

Using initial results of the first model output which investigated factors influencing attendance, the odds ratios associated with IMD as a predictor of uptake were approximately linear and therefore IMD could be treated as a continuous variable (as shown in *Figure 49*). However, IMD itself is not explicitly linear – the difference between decile one and decile two is not necessarily equivalent to the difference between decile three and four. This sensitivity analysis is shown in 9.1.6. For simplicity of explanation, and use in the real world, IMD was

entered into the model as a categorical variable with IMD(1) (most deprived) used as the baseline comparator.

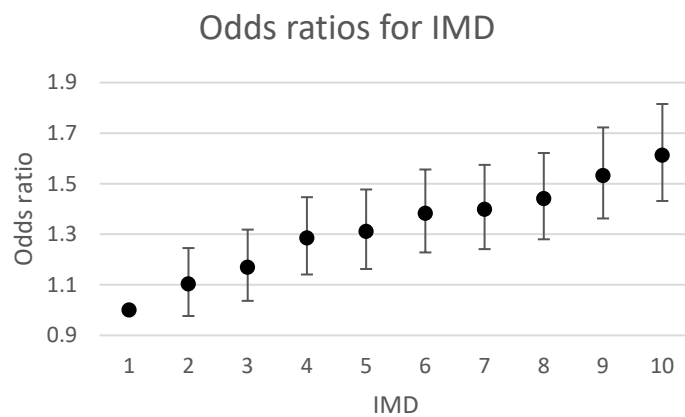


Figure 49. Odd ratio output graphically presented for the odds ratios in the first model building exercise.

After models were selected, post-estimation receiver-operator curves (ROC) were used to assess the applicability of the model built. A few, random, women were selected from the database based on their different characteristics and the estimated likelihood of attendance compared.

Whilst building models, all variables were included but were removed in a backward stepwise elimination based on their significance and effect

4.5 Results

All odds ratio (OR) results will be reported with their ninety-five percent confidence interval in parentheses unless otherwise stated. Similarly, all results have been rounded to two decimal places (dp) unless otherwise stated.

4.5.1 Descriptive statistics

The number of episodes of screening that fell into each sub-category of each variable are shown below in *Table 14*.

Table 13. Number of mammography screening episodes between 2000 and 2017 by each included predictor variable. Percentage column may not sum to 100% due to rounding.

Categorical Variable	Invited N	Percentage (%)
Total (all women)	915,546	100.0
Age		
<50 years	36,977	4.0
50-59 years	520,182	56.8
60-69 years	337,089	36.8
70+ years	21,298	2.3
IMD		
1 (most deprived)	7,529	0.8
2	57,472	6.3
3	70,133	7.7
4	98,160	10.7
5	78,453	8.6
6	108,110	11.8
7	96,859	10.6
8	119,966	13.1
9	169,240	18.5
10 (least deprived)	107,983	11.8
Ethnicity		
Asian – Other	20,698	2.3
Asian – Bangladeshi	1,823	0.2
Asian – Indian	25,623	2.8
Asian – Pakistani	8,401	0.9
Black – African	18,089	2.0
Black – Other	1,359	0.1

Categorical Variable	Invited N	Percentage (%)
Black – Caribbean	27,458	3.0
Mixed – Other	3,010	0.3
Mixed – White and Asian	3,497	0.4
Mixed – White and Black African	1,758	0.2
Mixed – White and Black Caribbean	2,986	0.3
Other – Any other	6,480	0.7
Other – Chinese	7,973	0.9
White – Other	40,693	4.4
White – British	415,500	45.2
White – Irish	17,824	1.9
Ethnicity – Not recorded	315,374	34.3
Special (Reason)		
None	897,833	98.0
Yes	17,713	2.0
Agoraphobia	2	0.01
Implants	1,225	0.14
Learning Difficulties - Other	1	0.01
Learning Difficulties – Wheelchair user	1	0.01
Learning Difficulties	1,324	0.15
Other – Physical restriction	7	0.01
Other – Registered disabled	3	0.01
Other – Wheelchair user	4	0.01
Other	1,946	0.22
Physical restriction – Wheelchair user	26	0.01
Physical restriction	945	0.11
Registered disabled	285	0.03
Social reasons	29	0.01
Wheelchair user	1,590	0.18

Categorical Variable	Invited N	Percentage (%)
Year	Invited (N)	
2000	34,668	3.8
2001	40,566	4.4
2002	41,496	4.5
2003	37,977	4.1
2004	43,205	4.7
2005	41,109	4.5
2006	52,956	5.8
2007	56,061	6.1
2008	48,526	5.3
2009	50,869	5.5
2010	54,450	5.9
2011	53,245	5.8
2012	49,737	5.4
2013	48,483	5.3
2014	68,953	7.5
2015	54,089	5.9
2016	63,002	6.9
2017	77,487	8.5
Month	Invite (N)	
January	79,446	8.6
February	76,804	8.4
March	83,273	9.1
April	65,065	7.1
May	75,936	8.3
June	74,540	8.1
July	76,833	8.4
August	72,175	7.9
September	82,766	9.0

Categorical Variable	Invited N	Percentage (%)
October	84,137	9.2
November	83,173	0.1
December	64,398	7.0
Day of the week	Invited (N)	
Monday	147,979	16.2
Tuesday	195,869	21.4
Wednesday	207,857	22.7
Thursday	216,927	23.7
Friday	146,924	16.0
Time of day	Invited (N)	
Morning	475,446	51.9
Afternoon	440,100	48.1
Attended at any point within each episode	915,546	N/A
Attended the first appointment within the episode	915,546	N/A
Recalled for further assessment and subsequent attendance	2,236	N/A

Appendix 8.3.5 presents a more detailed summary of each variable included in the dataset. Whilst preparing the dataset for analysis, it was noted that there were up to twelve appointments within a screening episode round as detailed in *Table 15*. The mean number of appointments was 1.4 (1dp) and the median number of appointments per episode was one.

Table 14. Frequency of maximum number of appointments invited per episode.

Maximum number of appointments per episode	Frequency
1	621,313
2	304,744
3	42,050
4	9,205
5	2,168
6	500
7	165
8	41
9	17
10	7
11	1
12	1

4.5.2 Representativeness of the sample

To assess the generalisability of the findings it is important that the dataset could be compared with statistics on the general population. Census data from 2011 that described the female composition of England and Wales by ethnicity as shown below (366). A larger proportion in the routine SW London dataset came from minority ethnic women compared with the census data.

Census data (of women aged between 47 and 73) from 2014 (as a projection from 2011 census data) were used to describe differences in the age composition of the sample used compared to the national average and this is shown in Figure 51. There is a large difference in the age composition of the samples. The routine SW London dataset had a much larger representation of women from 50-59 year group and 60-69 year group compared with the census data which had more women in the lower and higher age groups (367).

Twenty-two percent of London's boroughs fall within the most deprived 20% of the UK but simultaneously more than two thirds of London have deprivation levels above the national average (360). London scores poorly due to its high levels of deprivation such as crime, housing barriers and its environment despite having low levels of unemployment and high levels of education and training (360).

In the routine SW London dataset, there is a large proportion of women from affluent groups of the population. However, in the census dataset the distribution across deprivation levels is fairly equal distributions (367).

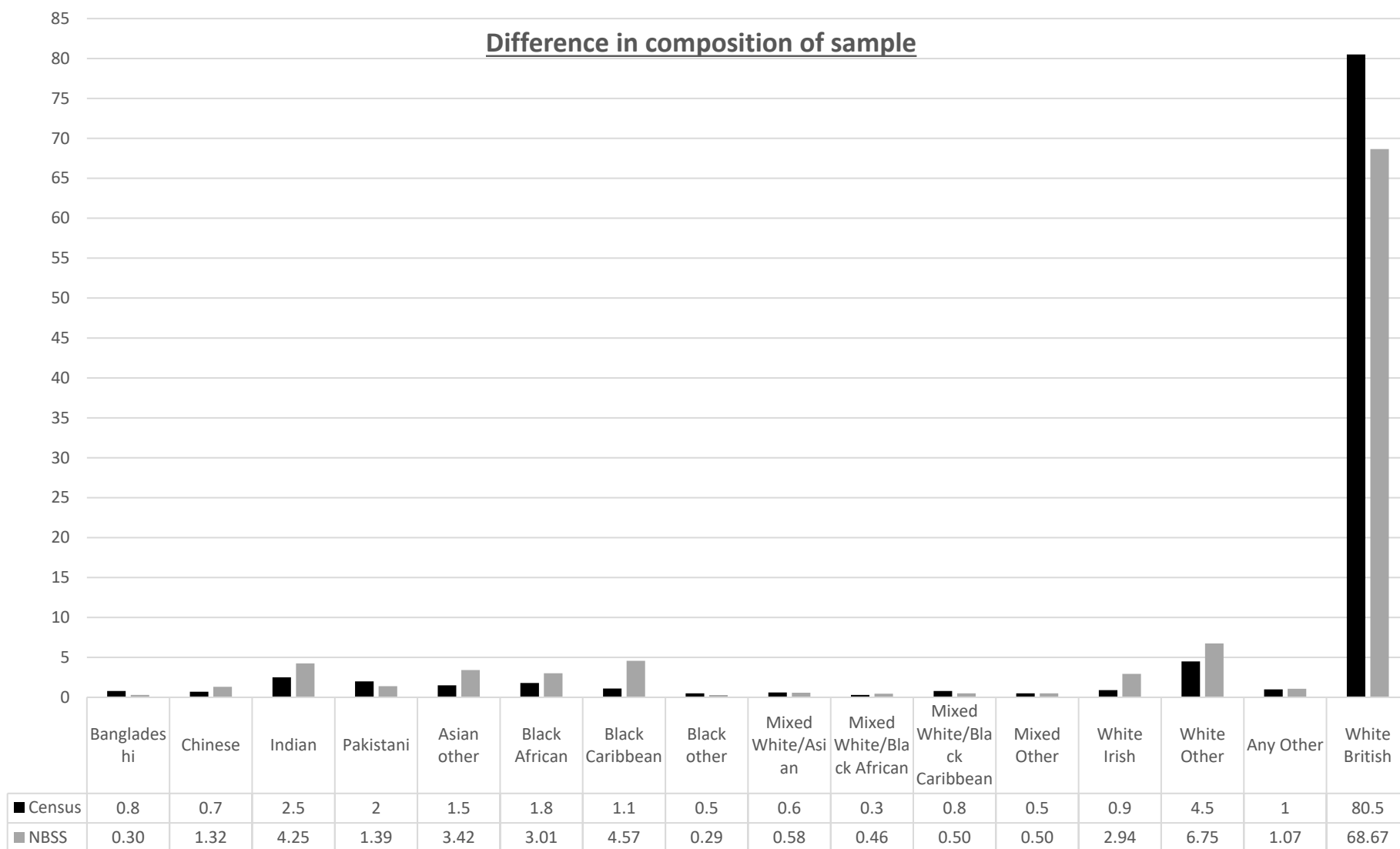


Figure 50. Ethnicity composition of the sample (routine SW London dataset) compared with female only Census data (2011). In general, minority ethnicities are over-represented whilst White British are under-represented compared to the general population (366).

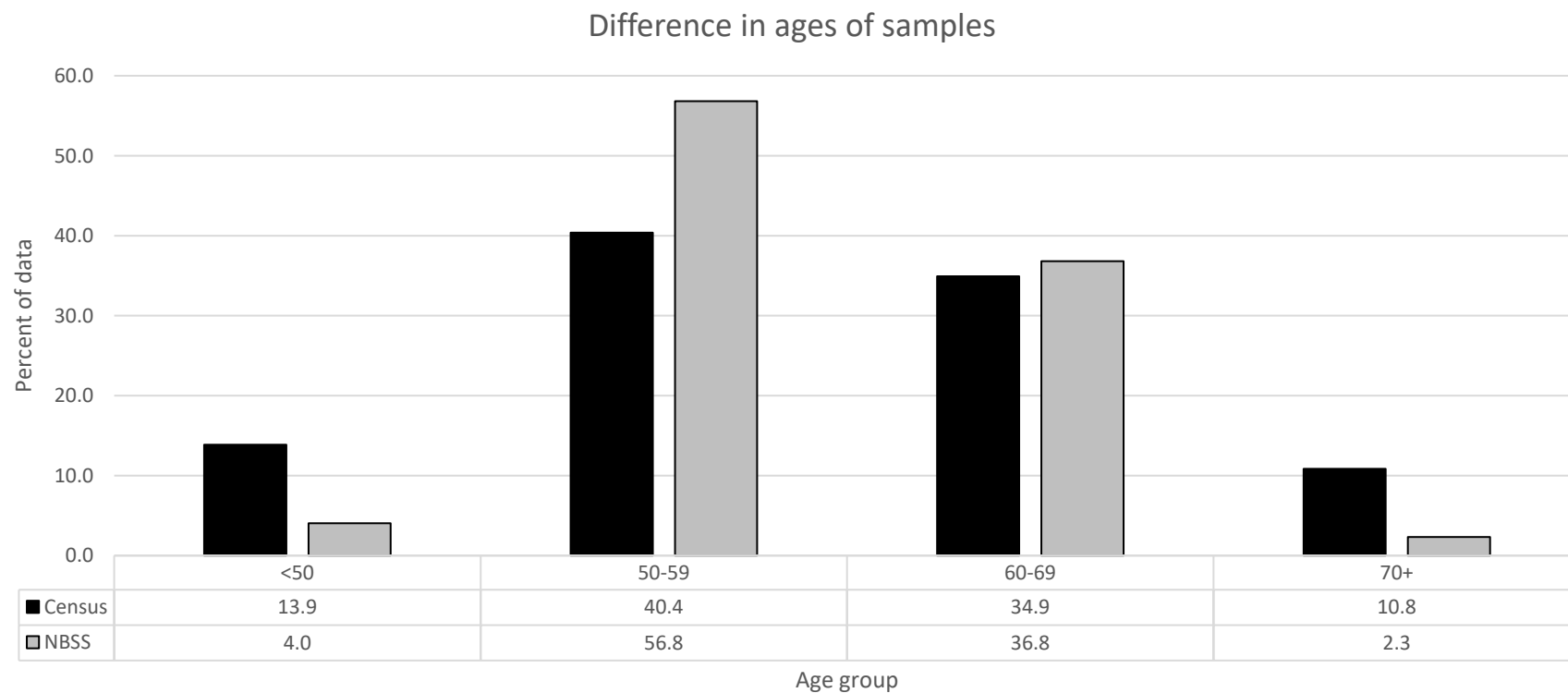


Figure 51. Age composition of the sample (routine SW London dataset) compared with female only data of women aged 47 to 73 years (Census data is projections of 2014 composition) (367).

Actual attendances

Overall, 590,047/915,546 (64.45%) of episodes were attended between 2000 and 2017.

The number of women attending and not attending were calculated for each group of the key predictor variables and are presented with the percentages in *Table 16*.

Table 15. Number of mammography screening episodes attended and not attended between 2000 and 2017 by each included predictor variable. Row percentages are calculated.

Categorical Variable	Attended N (%)		Did not attend N (%)		Invited N
Total (all women)	590,047	64.45	325,499	35.55	915,546
Age					
<50 years	22,835	61.75	14,142	38.25	36,977
50-59 years	335,543	64.50	184,639	35.50	520,182
60-69 years	218,628	64.86	118,461	35.14	337,089
70+ years	13,041	61.23	8,257	38.77	21,298
IMD					
1 (most deprived)	4,201	55.80	3,328	44.20	7,529
2	32,932	57.30	24,540	42.70	57,472
3	40,738	58.09	29,395	41.91	70,133
4	59,030	60.14	39,130	39.86	98,160
5	49,024	62.49	29,429	37.51	78,453
6	69,546	64.33	38,564	35.67	108,110
7	62,886	64.93	33,973	35.07	96,859
8	80,071	66.74	39,895	33.26	119,966
9	115,335	68.15	53,905	31.85	169,240
10 (least deprived)	75,314	69.75	32,669	30.25	107,983
Ethnicity					
Asian – Other	15,899	76.81	4,799	23.19	20,698
Asian – Bangladeshi	1,341	73.56	482	26.44	1,823
Asian – Indian	20,446	79.80	5,177	20.20	25,623
Asian – Pakistani	5,982	71.21	2,419	28.79	8,401

Categorical Variable	Attended N (%)		Did not attend N (%)		Invited N
Black – African	13,446	74.33	4,643	25.67	18,089
Black – Other	1,318	75.97	41	24.03	1,359
Black – Caribbean	22,135	80.61	5,323	19.39	27,458
Mixed – Other	2,313	76.84	697	23.16	3,010
Mixed – White and Asian	2,730	78.07	767	21.93	3,497
Mixed – White and Black African	1,306	74.29	452	25.71	1,758
Mixed – White and Black Caribbean	2,365	79.20	621	20.80	2,986
Other – Any other	4,967	76.65	1,513	23.35	6,480
Other – Chinese	6,389	80.13	1,584	19.87	7,973
White – Other	31,033	76.26	9,660	23.74	40,693
White – British	346,103	83.30	69,397	16.70	415,500
White – Irish	14,442	81.03	3,382	18.97	17,824
Ethnicity - Not recorded	99,190	31.42	216,542	68.58	315,732
Special (Reason)					
None	579,596	64.55	318,237	35.45	897,833
Yes	10,451	59.00	7,262	41.00	17,713
Agoraphobia	0	0	2	100	2
Implants	828	67.59	397	32.41	1,225
Learning Difficulties - Other	1	100	0	0	1
Learning Difficulties – Wheelchair user	0	0	1	100	1
Learning Difficulties	748	56.50	576	43.50	1,324
Other – Physical restriction	3	42.86	4	57.14	7
Other – Registered disabled	3	100	0	0	3
Other – Wheelchair user	4	100	0	0	4
Other	1,038	53.34	908	46.66	1,946
Physical restriction – Wheelchair user	18	69.23	8	30.77	26
Physical restriction	678	71.75	267	28.25	945
Registered disabled	184	64.56	101	35.44	285

Categorical Variable	Attended N (%)		Did not attend N (%)		Invited N
Social reasons	8	27.59	21	72.41	29
Wheelchair user	1,007	63.33	583	36.67	1,590

It is hypothesised by policymakers at SW London breast screening centre and Coventry breast screening centre, with whom I initially discussed plans for this thesis, that rates of attendance are decreasing. The raw percentages of numbers of women attending by year are shown in *Table 17* below. In this dataset, there appears to be a decreasing trend by year, except in 2006. It was also hypothesised that certain periods of the year would have higher rates of non-attendance than others. As shown, December has a lower attendance rate compared with the other months of the year.

Table 16. Number of women attending and not attending mammography screening episodes between 2000 and 2017 by each included predictor variable. Row percentages are calculated. Data from 2018 appears to be a selection of the population and not representative of the general population.

Variable	Numbers attended (n)	Percent attended (%)	Numbers not attended (n)	Percent not attended (%)	Invited N
Year (of first offered appointment)					
2000	23,555	67.94	11,113	32.06	34,668
2001	27,343	67.40	13,223	32.60	40,566
2002	26,949	64.94	14,547	35.06	41,496
2003	24,516	64.55	13,461	35.45	37,977
2004	29,453	68.17	13,752	31.83	43,205
2005	26,884	65.40	14,225	34.60	41,109
2006	33,238	62.77	19,718	37.23	52,956
2007	36,257	64.67	19,804	35.33	56,061
2008	31,031	63.95	17,495	36.05	48,526
2009	32,197	63.29	18,672	36.71	50,869

Variable	Numbers attended (n)	Percent attended (%)	Numbers not attended (n)	Percent not attended (%)	Invited N
2010	35,527	65.25	18,923	34.75	54,450
2011	35,214	66.14	18,031	33.86	53,245
2012	31,848	64.03	17,889	35.97	49,737
2013	31,244	64.44	17,239	35.56	48,483
2014	44,011	63.83	24,942	36.17	68,953
2015	35,286	65.24	18,803	34.76	54,089
2016	41,365	65.66	21,637	34.34	63,002
2017	44,129	58.46	33,358	41.54	77,487
Month (of first offered appointment)					
January	50,898	64.07	28,548	35.93	79,446
February	46,932	63.59	26,872	36.41	76,804
March	53,913	64.74	29,360	35.26	83,273
April	43,388	66.68	21,677	33.32	65,065
May	49,536	65.23	26,400	34.77	75,936
June	48,765	65.42	25,775	34.58	74,540
July	50,387	65.58	26,446	34.42	76,833
August	47,412	65.69	24,763	34.31	72,175
September	53,389	64.51	29,377	35.49	82,766
October	55,247	65.66	28,890	34.34	84,137
November	52,342	62.93	30,831	37.07	83,173
December	37,838	58.76	26,560	41.24	64,398
Day of week (of first offered appointment)					
Monday	95,933	64.83	52,046	35.17	147,979
Tuesday	126,424	64.55	69,445	35.45	195,869
Wednesday	133,750	64.35	74,107	35.65	207,857

Variable	Numbers attended (n)	Percent attended (%)	Numbers not attended (n)	Percent not attended (%)	Invited N
Thursday	140,151	64.61	76,776	35.39	216,927
Friday	93,799	63.84	53,125	36.16	146,924
Time of day (of first offered appointment)					
Morning	305,555	64.27	169,891	35.73	475,446
Afternoon	284,492	64.64	155,608	35.36	440,100

The number of women who attended the following scenarios was calculated and is presented below:

Table 17. Number of women attending and not attending as per the specific situation specified.

	Attended	(%)	Did not attend	(%)	Invited N
Attended at any point within each episode	590,047	64.45	325,499	35.55	915,546
Attended the first appointment within the episode	369,766	40.39	545,780	59.61	915,546
Recalled for further assessment and subsequent attendance	191,515	62.28	116,014	37.72	307,529

However, I am interested in the relative effects of these variables and influences and subsequently multivariable modelling was necessary.

4.5.3 Factors influencing uptake of mammography for any episode

For this question, all data in the final database were used for the analysis to answer what factors were associated with uptake of mammography.

As discussed in Chapter four above a Bonferroni adjustment needed to be made to account for multiple testing of a single dataset. Here, three different models were tested so the appropriate adjustment was considered to be a Bonferroni adjustment, $\alpha/n = 0.05/3 = 0.0167$ (260). LR tests were used to compare models.

Compared with women aged under 50 years, the odds of older women attending were significantly lower as shown in Table 19. The odds of attendance for women who did not require a special appointment were 96% higher compared with women who did require a special appointment, OR 1.96 (1.82, 2.12). Women who had previously been recalled for further assessment had 21% higher odds of attending than women who had not been recalled, OR 1.21 (1.19, 1.24). Apart from the deprived end of the IMD scale where no significant difference was observed between IMD deciles one and two ($p=0.126$) or between one and three ($p=0.017$), the odds of attending BCS increased with affluence compared to the lowest IMD women with odds of attending 64% higher for affluent women (IMD=10) compared with deprived women (IMD=1), OR 1.64 (1.45, 1.84). Women of all minority ethnicities had lower odds of attendance when compared with White British women. ICC was 34.48% (33.99, 34.97) meaning that even individual women exhibit some variability as to whether or not they will attend screening. Unless specified all p-values were <0.001 .

Table 18. Odds ratio for each predictor of attendance included in the final model for any episode. Fully adjusted data. Unknown ethnicity data was classed as 'Other'. Figure 52 depict these associations.

Predictor	Sub-group	Odds ratio (95% confidence interval)	p-value
Age categorical	<50 years	1	
	50-59 years	0.78 (0.74, 0.82)	0.000
	60-69 years	0.83 (0.79, 0.87)	0.000
	70+ years	0.61 (0.57, 0.65)	0.000
Special appointment	No	1	
	Yes	1.98 (1.83, 2.13)	0.000
Previous recall	No	1	
	Yes	1.22 (1.19, 1.24)	0.000
IMD	1	1	
	2	1.10 (0.97, 1.24)	0.126
	3	1.16 (1.03, 1.31)	0.017

Predictor	Sub-group	Odds ratio (95% confidence interval)	p-value
	4	1.29 (1.14, 1.45)	0.000
	5	1.32 (1.17, 1.49)	0.000
	6	1.39 (1.23, 1.56)	0.000
	7	1.40 (1.25, 1.58)	0.000
	8	1.46 (1.29, 1.64)	0.000
	9	1.55 (1.38, 1.75)	0.000
	10	1.64 (1.45, 1.84)	0.000
Ethnicity	White	1	
	Asian	0.69 (0.66, 0.71)	0.000
	Black	0.78 (0.76, 0.82)	0.000
	Mixed	0.72 (0.67, 0.78)	0.000
	Other	0.73 (0.69, 0.78)	0.000

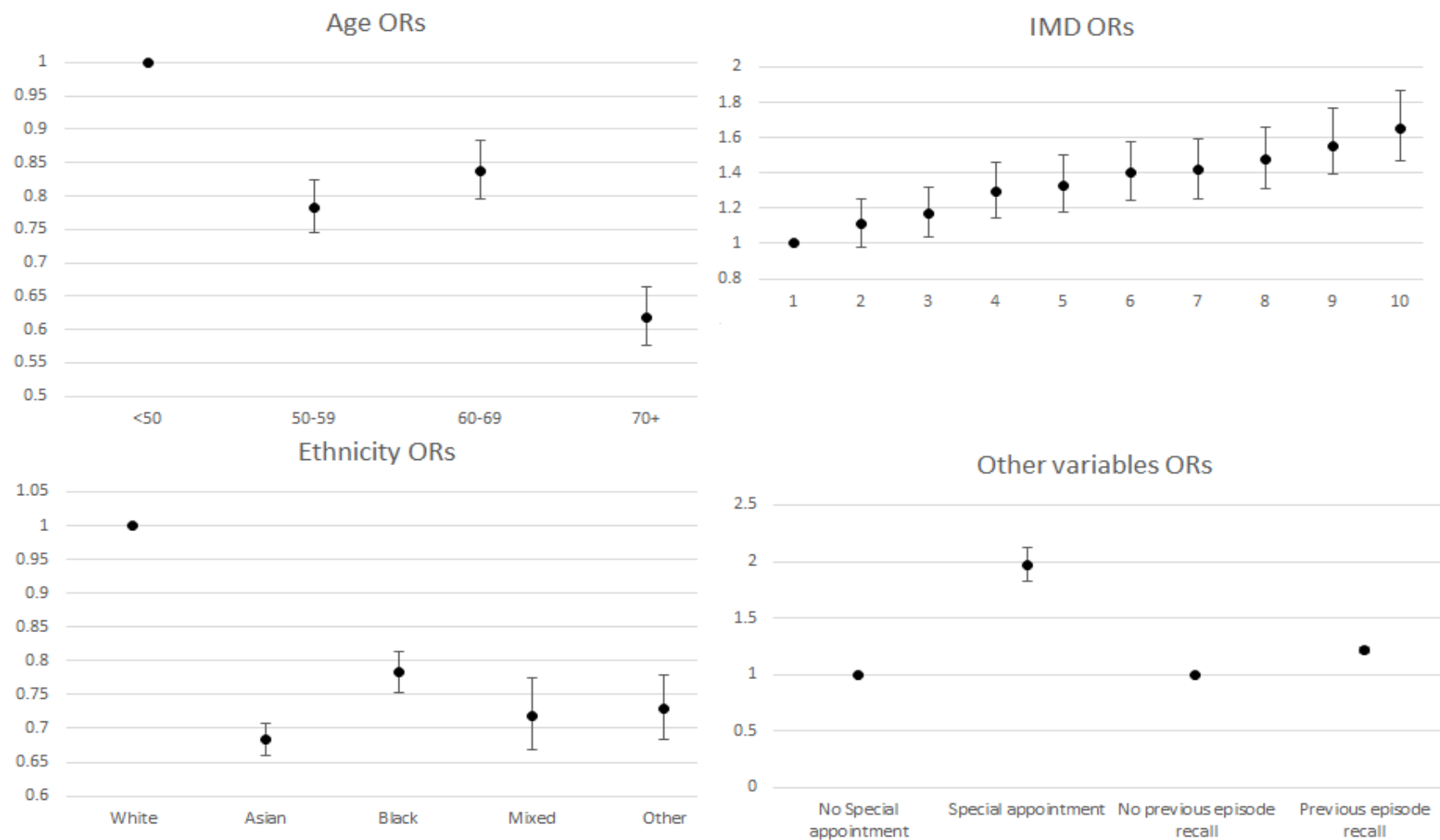


Figure 52. Graphical representation of the odds ratio results for attendance at any episode as discussed above.

Date of episode was not considered in the model as it is not clinically relevant for this research question as multiple appointments (with different dates) are analysed. Interaction effects were explored in this model but most resulted in perfect prediction or offered no significant improvement to the model. The only interaction that may have remained in the model, according to a LR test, was the interaction of age and ethnicity. However, some of the resulting subgroups contained small numbers of participants, and the estimates for baseline ethnicity (White) became non-significant, making interpretation of the interaction terms difficult. Sensitivity analyses were conducted on models including and not including an interaction between age and S IMD ES which showed little difference on estimates except IMD became non-significant. Therefore the interaction term was removed.

Using post-estimation statistics for clarity, a highly affluent (defined as the highest level of IMD which is ten) White woman, aged between 50-59 years, requiring no special appointment, who had no previous recall had a probability of attending of $\text{Pr}(\text{attending})=0.895$ (3dp). A different highly affluent White women, aged between 50-59 years, requiring a special appointment, with a previous recall had a probability of attending of $\text{Pr}(\text{attending})=0.840$ (3dp).

Receiver-operator curves (ROC) provides a summary measure of accuracy of the model to discriminate between attenders and non-attenders. An AUC value below 0.5 is considered non-informative, with increasing values indicating increasing accuracy (less accurate ($0.5 < \text{AUC} \leq 0.7$), moderately accurate ($0.7 < \text{AUC} \leq 0.9$), highly accurate ($0.9 < \text{AUC} \leq 1$) and perfect ($\text{AUC}=1$)) (368). The area under the curve (AUC) is 0.908 (0.908, 0.909) meaning the model is good at discriminating attenders from non-attenders.

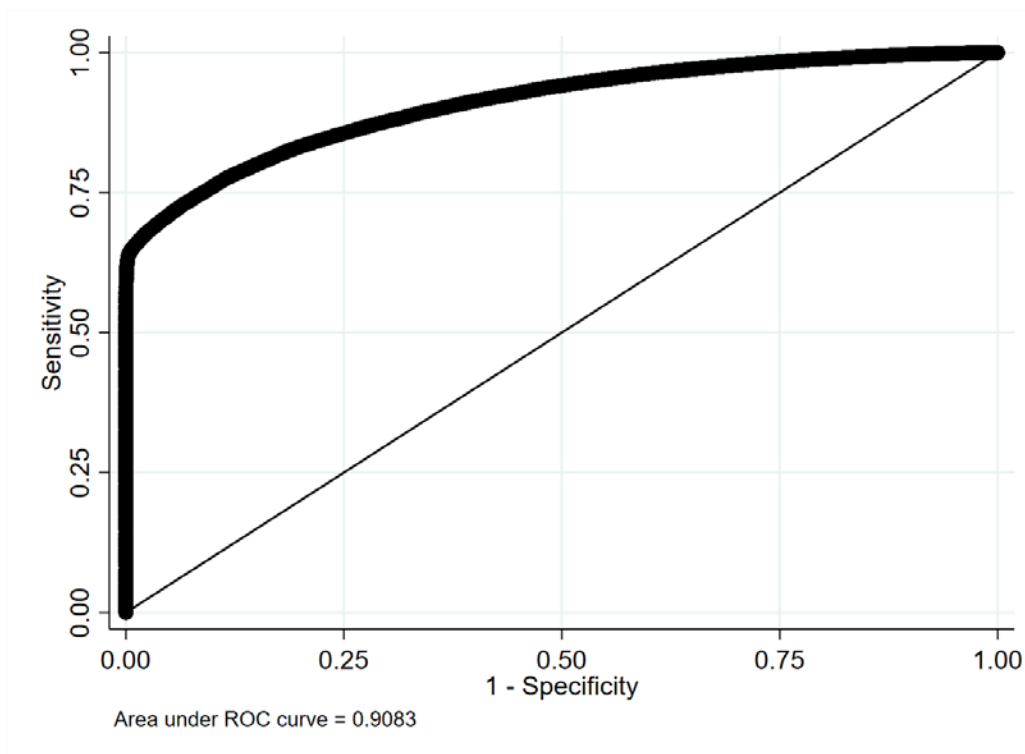


Figure 53. ROC curve for research question one: what influences attendance at any point in the episode.

4.5.4 Factors influencing attendance at first episode

There were 205,433 episodes that were relevant for this analysis as they involved the first time women were invited to screening and were analysed here. Of these episodes, 121,973 (59.37%) attended screening within their first episode and 83,460 did not (40.63%). The oldest a woman can be when invited to her first screening appointment is 53 years.

Overall, four different models were compared to identify the best selected model for attendance at the first episode. Again, to reduce the likelihood of a type one error in this analysis, a Bonferroni statistic of $p=0.0125$ was used for each model's individual significance value (260, 261). The inclusion of covariates in nested models were verified using LR tests as described above.

The final model for the first episode attendance included age, special appointment status, ethnicity and IMD. The results of this can be seen in *Figure 54* below.

Table 19. Odds ratio estimates with 95% confidence intervals and p-values for the predictors included in the final model.

Predictor	Sub-group	Number of episodes	OR (95% confidence interval)	p-value
Age	47	5,028	1	
	48	5,302	0.61 (0.44, 0.86)*	0.004
	49	27,043	0.15 (0.11, 0.19)	0.000
	50	54,863	0.15 (0.12, 0.20)	0.000
	51	52,042	0.16 (0.12, 0.12)	0.000
	52	40,255	0.14 (0.10, 0.18)	0.000
	53	20,900	0.08 (0.06, 0.10)	0.000
Special appointment	No	202,274	1	
	Yes	3,159	0.49 (0.43, 0.56)	0.000
IMD	1 (low)	1,787	1	
	2	14,248	1.25 (1.01, 1.55)	0.040
	3	16,875	1.22 (0.98, 1.50)	0.070
	4	23,016	1.26 (1.02, 1.55)	0.032
	5	17,811	1.25 (1.01, 1.54)	0.041
	6	23,663	1.29 (1.05, 1.59)	0.016
	7	21,431	1.36 (1.11, 1.69)	0.004
	8	26,084	1.33 (1.08, 1.64)	0.007
	9	36,860	1.35 (1.10, 1.66)	0.004
	10 (high)	23,272	1.44 (1.17, 1.78)	0.001
Ethnicity	White	85,751	1	
	Asian	11,630	0.75 (0.71, 0.79)	0.000
	Black	11,117	0.83 (0.78, 0.89)	0.000
	Mixed	2,551	0.81 (0.71, 0.91)	0.000
	Other	3,241	0.80 (0.72, 0.89)	0.000

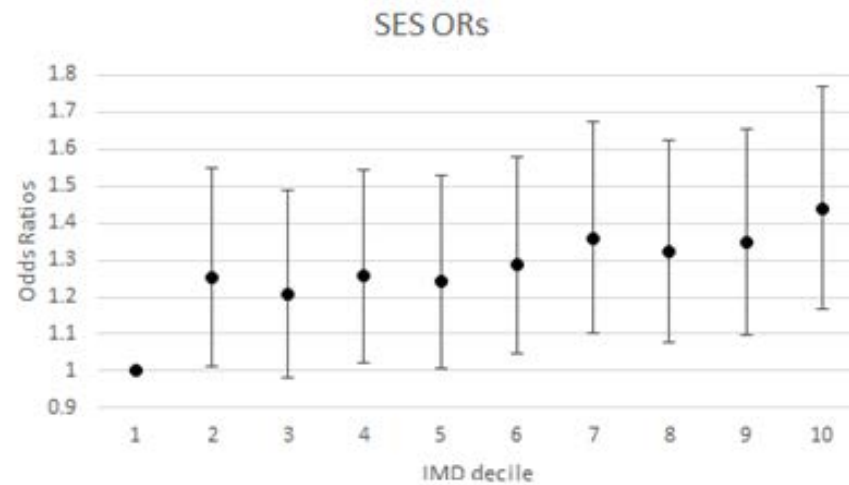
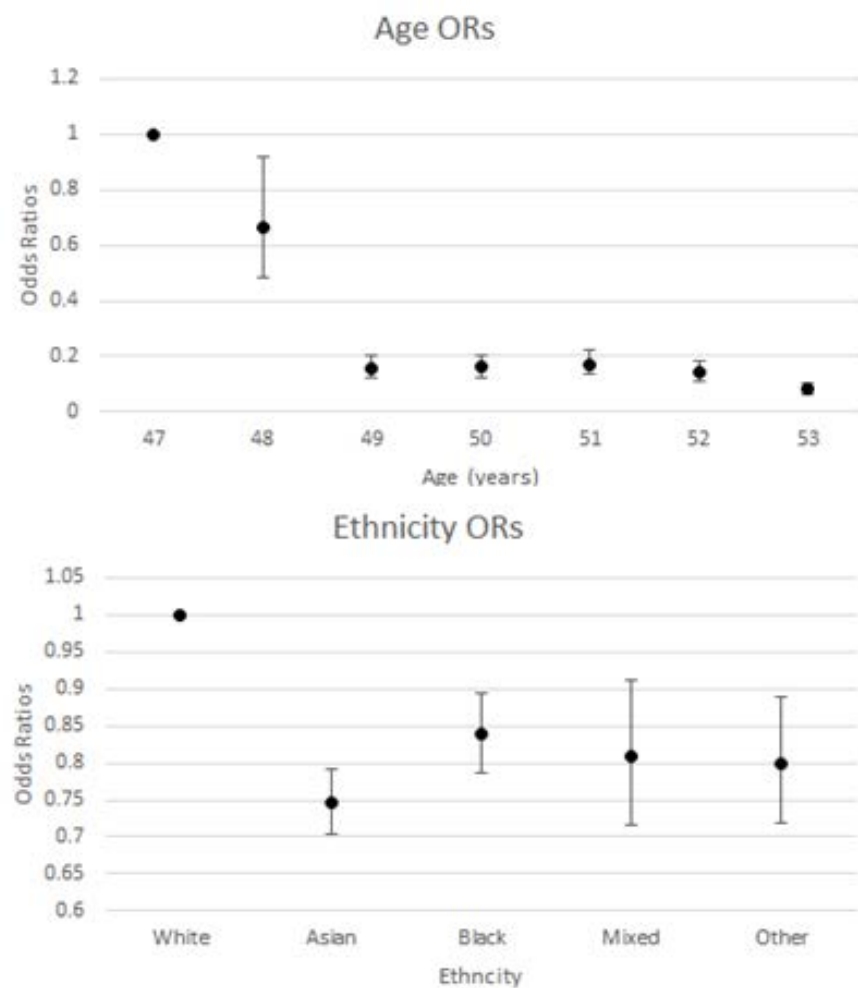


Figure 54. Graphical representation of the odd ratio results for research question two as discussed above.

As age increased odds of attendance were at least 30% lower compared with the youngest women. Odds of attending ranged from OR 0.67 (0.48, 0.92) for women aged 48 compared with 47 to OR of attendance 0.08 (0.06, 0.11) for women aged 53 compared with 47. For women requiring a special appointment, the odds of attending were lower than women not requiring a special appointment, OR 0.50 (0.43, 0.57). All minority ethnic women had lower odds of attending than White British women, for instance Asian women were 25% lower than White women, OR of 0.75 (0.70, 0.79). The odds of affluent women attending were significantly higher than those of lower socioeconomic status women. Only IMD categories seven to ten were significantly different from baseline (IMD one, low IMD). The odds of a highly affluent women (IMD 10) attending BCS were 44% higher than a socially deprived woman of IMD 1, OR 1.44 (1.17, 1.77).

Using post-estimation statistics a White affluent woman (IMD 10), aged 49 years, who did not require a special appointment and who had no previous recall had a probability of attending 0.920. A 50 year old Asian woman, IMD 3, not requiring a special appointment and who had no previous recall had a probability of attending of 0.812. A woman with the same characteristics but with IMD 10 had a probability of attending 0.886.

The AUC for the ROC was 0.99 (0.99, 0.99) and is shown below. This means the model is very good at discriminating attenders from non-attenders (368).

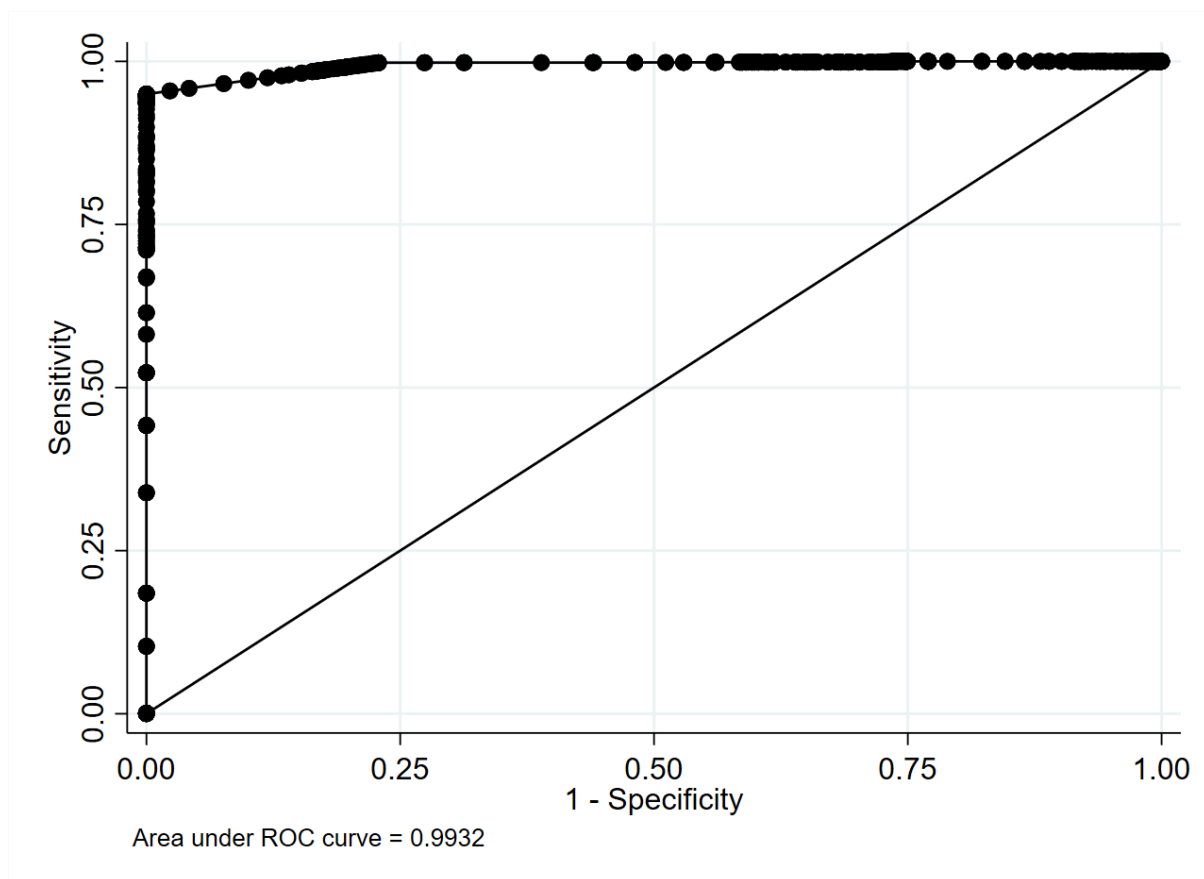


Figure 55. ROC graph for question two: what influences attendance at first episode

Data for the month of December were removed subsequently from this analysis to conduct a sensitivity analysis to account for the festive period. No significant differences were observed in the OR results and it made no difference which predictors were or were not significant.

4.5.5 Have influences of mammography attendance changed over time?

For this research question, only data in 2001 or 2016 were used for analysis. 40,516 women were present in the 2001 analysis and 64,678 women in the 2016 analysis.

Year of the episode was found to be a significant predictor of attendance at any point within an episode. The odds of attending BCS were 2% lower per each additional year from 2000, OR 0.98 (0.97, 0.98). Therefore, year was investigated further, in particular whether there were any noticeable changes in factors influencing attendance in 2001 compared to 2016. I used two different cohorts (2001 and 2016) that were well apart in terms of screening round cycle so as to investigate the effects of year as far as possible separately from the effects of attendance by individual women.

Variables found to be significant predictors of uptake in the first research question (investigating predictors of attendance) were used again here as I had established they are important and associated with uptake.

Two-by-two cross tabulations were used to highlight potential differences between years. Overall, uptake was similar across both years for IMD. Large differences were observed for previous recall and requirement of a special appointment where both trends as shown below in *Figure 56*. The percentage attendance was very high for the oldest women in the database in 2001. However, I believe this is an anomalous result as numbers were very small (there was only one woman who was a non-attender whereas there were fifty-three attenders). Ignoring that age group, percentage attendance between 2001 and 2016 is broadly similar. Ethnicity appears to have changed the most over time. Attendance (and therefore non-attendance) appears to remain constant over the time-period examined for White women. All other ethnicities have lower percentages of uptake in 2001 compared with 2016 with the most noticeable change shown in women of Mixed ethnicity where attendance increases from 75.1% in 2001 to 84.3% in 2016.

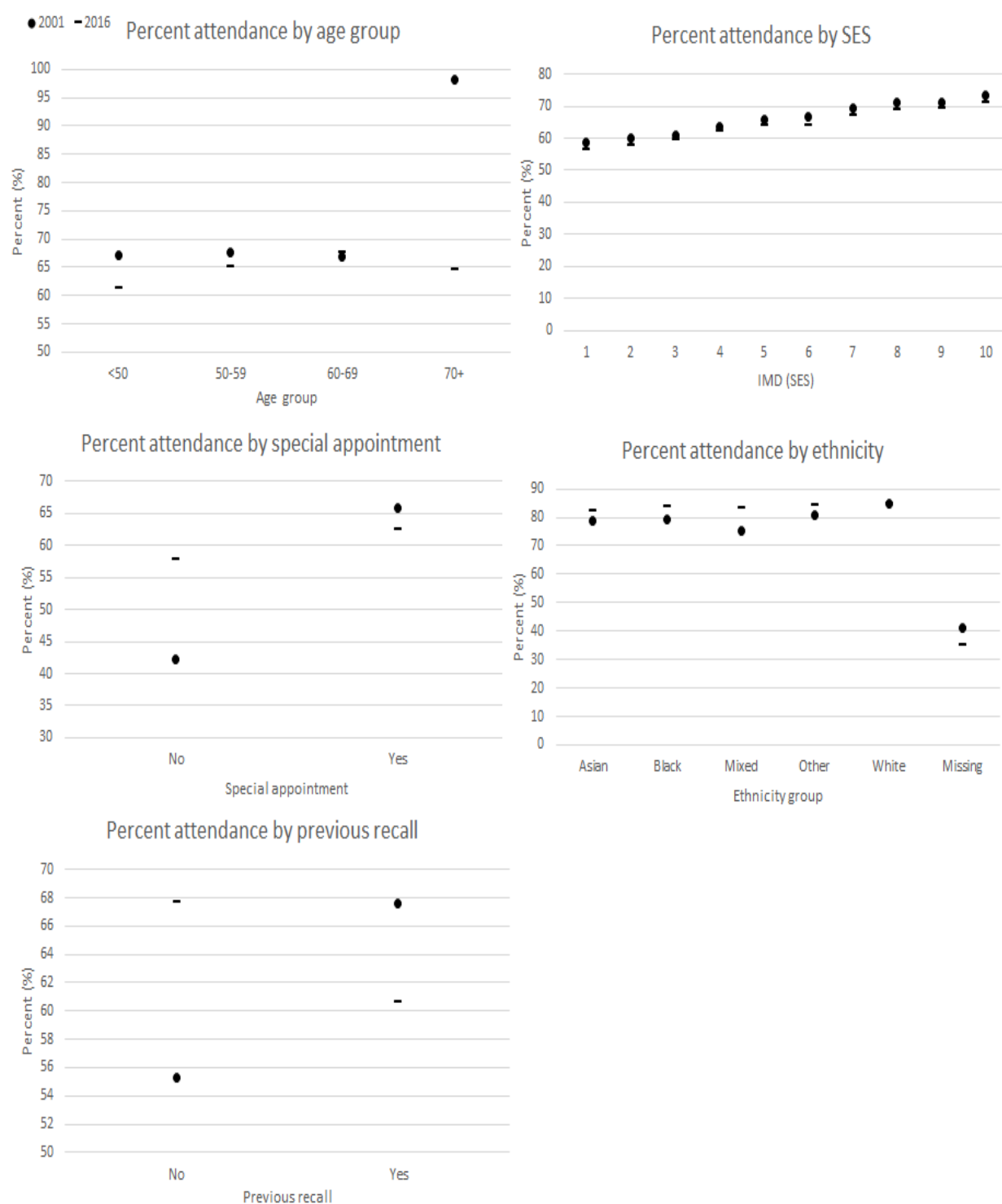


Figure 56. Cross tabulation results for changes in attendance by year.

Univariate models were used to capture differences in predictors of uptake between the years. These are presented in *Table 21* below.

Table 20. Comparison of odds ratios of univariate predictors of attendance in 2001 and 2016. *=indicator of a significant result at the 95% significance level. Data for the 70+ years group has been included for reference and transparency. However, this group represents a very small sample size and therefore the confidence interval estimates are large.

Predictor	Subgroup	2001	2016
		OR (95% confidence interval)	OR (95% confidence interval)
<u>Age</u>	<50 years	1	1
	50-59 years	1.02 (0.90, 1.15)	1.19 (1.12, 1.26)*
	60-69 years	0.98 (0.86, 0.11)	1.33 (1.25, 1.41)*
	[70+ years]	[25.82 (3.56, 187.40)*]	[1.15 (1.06, 1.25)*]
<u>Special appointment</u>	No	1	1
	Yes	0.65 (0.59, 0.73)*	0.87 (0.75, 1.01)*
<u>Ethnicity</u>	White	1	1
	Asian	0.66 (0.58, 0.74)*	0.84 (0.77, 0.92)*
	Black	0.69 (0.60, 0.79)*	0.92 (0.84, 1.00)*
	Mixed	0.54 (0.42, 0.69)*	0.88 (0.74, 1.05)
	Other	0.74 (0.57, 0.95)*	0.96 (0.82, 1.13)
<u>Previous recall</u>	No	1	1
	Yes	1.70 (0.49, 1.93)*	0.74 (0.71, 0.76)*
<u>Socio-economic status</u>	1 (deprived)	1	1
	2	1.06 (0.81, 1.39)	1.06 (0.83, 1.34)
	3	1.08 (0.83, 1.42)	1.14 (0.90, 1.45)
	4	1.22 (0.93, 1.58)	1.26 (0.99, 1.60)
	5	1.34 (1.03, 1.75)*	1.37 (1.08, 1.74)*
	6	1.40 (1.07, 1.82)*	1.36 (1.08, 1.73)*
	7	1.58 (1.21, 2.06)*	1.56 (1.22, 1.98)*
	8	1.72 (1.32, 2.24)*	1.69 (1.33, 2.14)*
	9	1.72 (1.32, 2.23)*	1.73 (1.37, 2.19)*
	10 (affluent)	1.92 (1.47, 2.50)*	1.90 (1.50, 2.41)*

4.6 Discussion

It is worth acknowledging that whilst trying to build the best model, the “true model” that exists in the real world, with multiple other confounding variables, will never be achievable with this dataset. The aim of model selection is to find the best way of explaining a high proportion of variance. Model selection is a balance between an ‘Occam’s razor’ approach where the simplest solution is the best and the idea that by adding more parameters we can obtain a better explanatory model (369).

Mixed effects multilevel models were used to assess predictors of attendance using data from a SW London screening centre. Odd ratio results were compared between 2001 and 2016 to assess if predictors of uptake had changed.

Furthermore, comparison of these results with the findings of the systematic review have been discussed in Chapter 7.

4.6.1 My results compared with previous research

A more detailed comparison of the results from the review and the secondary data analysis is provided in Chapter 7.

4.6.1.1 Factors influencing uptake of mammography at any episode

A study by Banks *et al.* found no significant difference in attendance between women of different ages (133). Here, older women were significantly less likely to attend BCS as supported by previous research (295, 370), and also specifically in research in London, UK which also found lower attendance in older age groups (148). This may be due to competing health complaints or the lack of expected benefits from screening for older patients.

This trend is also true for minority-ethnic women. Lower uptake in this group has been frequently reported in the literature as a major source of health inequality (55, 131, 137, 140, 248, 252, 263, 292, 319, 321). Decreasing odds of attendance were found with increasing social deprivation by Maheswaran *et al.* in North Derbyshire and this is reflected in the results we found for this research question (371).

Women requiring a special appointment, due to disability or breast implants also had higher odds of attending BCS than women who did not require a special appointment as did women with a previous recall compared with those without a previous recall. Previous research has found conflicting results and so this finding is extremely important in the field of re-

attendance following a false positive result. Brewer *et al.* (372) in America and Sim *et al.* (373) in Australia found lower re-attendance rates following a false positive result but Andersen *et al.* in Denmark found no significant difference (262). In Ireland, Fitzpatrick *et al.* found re-attendance rates differed by type of recall procedure type and whether the recall was on the incident or prevalent round of screening (269). Our data did not have sufficient detail to identify types of recall appointment and therefore we cannot support or refute that association. Regardless, it is important and interesting that women with previous recalls have higher odds of attending BCS in this dataset.

4.6.1.2 Factors influencing attendance at the first episode

This model has predicted that the likelihood of attending at the first invited episode decreases with age when compared to women aged 47. This is similar to attendance at any episode, however the differences are more extreme.

The odds of attending BCS at the first episode were 50% lower amongst women requiring a special appointment compared with women who do not, OR 0.50 (0.43, 0.57). As found in the first research question (that minority ethnic women are less likely to attend mammography at any point), minority ethnic women are less likely to attend the first episode compared with White British women. IMD became a significant predictor of attendance at first episode for women of IMD7 and above compared with IMD4 for attendance at any point within an episode. However, this may be an artefact of the sample size more than a difference in attendance.

Despite lower than normal attendance overall in the month of December it was found that there were no differences in a model with or without the December data included. This perhaps is because for a women's first screening appointment the women who attend will aim to attend regardless of other commitments as it is such an important milestone in one's life.

4.6.1.3 Have influences of mammography attendance changed over time?

As I am using a much smaller sample size for each year compared with the overall database, any difference in terms of significance of variables may be due to lack of data, rather than a lack of actual effect. However, the sample sizes used are still large so this should not be a big concern.

Logistic regression was used for this research question as multilevel modelling was inappropriate for the type of data as there was no repetition of women (each woman was only invited once). The variables found in the previous models to be significantly associated with attendance were used in the logistic model.

Age

Even after removing women aged over seventy where the data are unreliable, non-attendance is higher (or similar) in 2016 compared with 2001 for all age groups. Care was taken to ensure women were not double counted in both datasets and consequently different media influences will have been apparent on each cohort that can make comparisons challenging. Odd ratios results were found to be very different between the year groups. In 2016 odd ratios for all ages were found to be significant compared with the youngest group. In 2001 only odd ratios for 70+ age group were significant when compared with the women aged under fifty years and the result was considered somewhat unreliable due to the large confidence interval. Therefore, only in 2016 was age found to be a significant predictor of uptake with older women having higher odds of attending BCS.

Special appointment

In 2016 both groups (women who did and did not require a special appointment) had lower rates of attendance than 2001. This is fitting with the overall trend that attendance is decreasing over time. Women requiring a special appointment had a higher rate of attendance than women without a special appointment requirement in 2016, perhaps this is due to better access to services and more inclusivity of the programme. As shown in *Table 22* the odds of attending BCS were only significantly lower in women requiring a special appointing in 2001 compared with women who did not require one, OR 0.65 (0.59, 0.73). In 2016, odds of attending mammography were not significantly different depending on the requirement of a special appointment, OR 0.87 (0.75, 1.01).

Ethnicity

Cross-tabulations show decreasing inequality in rates of attendance across ethnicities. This may be due to many public health campaigns targeted at reducing inequalities of access in these minority groups (352). The database had a wide range of ethnicities reported which is

useful and has significant advantages compared with many research studies which often under-represent ethnic minorities (352). However, this decreasing inequality may not be generalisable to the rest of the UK due to the heterogeneous population in this SW London sample.

Despite this, uptake of mammography in the UK is consistently found to be lower in women of ethnic minority compared to White British women (135). When compared with attendance of White women only the OR of Asian and Black women remained significant in both years analysed. However, the relative effect size (OR) was approximately 20-30% lower in 2001. As is shown by the lower attendances of women with 'missing' ethnicity data, this comparison may be biased by the sample used, ethnicity is more likely to be recorded in women who attend screening. Furthermore, the changes in uptake of ethnicity could have been influenced by improvements in the recording of ethnicity data rather than a definite sign of increased attendance of ethnic minorities.

Previous studies have also found this trend. Szczepura *et al.* reported in 2008 that rates of BCS uptake were increasing for South Asians at a faster rate than other ethnic minorities and the majority population (140). Furthermore, inequalities are reported to have narrowed elsewhere. In the USA the increase in uptake between 1991 and 1994 was larger among low-income Black women when compared against low-income White women. This difference is unaccounted for by confounding factors such as region or insurance (374). This is a good illustration of the changing trend of ethnic women's screening behaviour.

Previous recall

Higher rates of non-attendance were found in 2016 for women who have experienced a previous recall. Different women react to this experience differently but perhaps a change in the procedure occurred during this time frame that has deterred re-attendance. While both odd ratio estimates were significant, those for 2016 were larger, OR 0.53 (0.40, 0.66) meaning women with a previous recall in 2016 had higher odds of attending BCS than those without a previous recall. The effect of a false positive result in the literature is mixed (143, 249, 251, 372, 373, 375). Some suggest that re-attendance may vary depending on type of recall assessment, type of woman, and skills in information delivery by healthcare staff. However,

any change in trend has not explicitly been analysed to the best of my knowledge but it remains important in determining uptake patterns.

The analysis found an increasing trend of attendance in both year groups with increasing affluence. This finding is well documented throughout the literature (79, 124, 135, 136, 371). The difference between attendance in 2001 and 2016 appears inconsistent amongst different IMD groups. Odd ratios suggest approximately equal likelihoods of attendance across years with only odds ratios for groups IMD5 and above (more affluent women) being found significant as shown in *Table 21*.

4.6.2 Interaction effects

Interaction effects occur when the effect of one variable on an outcome is dependent on another variable. Including interaction effects can improve the fit of a statistical model output in a real-world setting, but sometimes at the cost of interpretability. Failing to include interaction terms means each variable is assumed to have an independent effect on the outcome, which may or may not be true. The interaction between age and IMD was considered in the model building process but was not included in the final model due to a lack of statistical significance. Hence no interactions were included in the final model.

4.7 Strengths and limitations

The largest strength of this study is the size of the database used. Data from 304,616 women were collected and analysed over an eighteen year timeframe. A large database is important as it provides sufficient power to identify smaller associations with the outcome variable. However, it gave a complicated picture of attendance as many variables were found to be significantly associated with attendance at mammography. The large number of variables being investigated also increases the chance of a type one error, as the large number of observations increases the chance of detecting a statistically significant, but clinically unimportant effect size. To counter the use of multiple model testing on the data a Bonferroni adjustment was used to reduce the likelihood of a type one error.

Multilevel modelling is a valuable method to modelling hierarchically organised data and outperforms the more basic logistic regression in predictive accuracy. As women are invited to screening every three years it was anticipated that women could have up to seven episodes between 2000 and 2018. Multilevel modelling accounts for the repeated measurements of

women and relaxes the assumption of independence of the observations. After fitting the best model to the data it also allows a prediction of each women's likelihood of attendance at mammography which is useful to provide a real-life estimate of attendance.

By using a secondary dataset there was no bias incorporated into the data by the researcher and this was a cost-effective means of collecting such a large amount of data. The data were routinely collected information by hospital staff at screening centres. However, this means that the analysis relied upon self-report for ethnicity and so for women who did not attend any appointments ethnicity data remained missing. Whilst there is no perfect way to obtain ethnicity information where the person themselves is unable to provide it, use of name recognition software (376) was not undertaken and the work relied upon self-reported information at attendance.

As with any large dataset previously collected for a different purpose, my analysis had to rely on the variables available and may therefore potentially miss important information that could be associated with the outcome of interest such as car access, marital status, employment status, distance travelled to the screening site etc. Furthermore, as mentioned earlier, the database was incomplete, particularly within the ethnicity domain which may have biased interpretation and results.

The data included in this dataset are not entirely representative of the ethnic diversity of England. The analysis was comprised of a larger proportion of ethnic minority women compared to the national average. This routine SW London database also favoured the middle age groups (50-59 years and 60-69 years) and had a larger proportion of affluent women than the census data. Therefore, it appears that the dataset is not generalisable to a nationwide scale. On the other hand, the population screened is more likely to reflect the London population from which it is drawn which has a higher proportion of ethnic minority women (135). This is discussed more in Section 5.8.

Analysis of this sort using an observational design can only ever identify associations not causality. There may be other confounding variables that are not included in this dataset but which are extremely important for determining association with uptake of mammography. Such confounding variables may include personality characteristics (such as propensity to

attend appointments, or fatalism, or health beliefs) or may be other structural characteristics which are as yet undescribed.

4.8 Representativeness of the data

Figure 50 shows the composition of this database (routine SW London dataset) compared with census data of 2011. It shows that this sample contains fewer White British women and more ethnic minority women than the national population. This could explain why the dataset is presenting a lower than average attendance overall (64.45%) compared with the national average (71.1%) (377) as much literature has previously reported lower uptakes in women of ethnic minority (137, 140, 248).

Routine SW London data used also had a larger representation of women from the 50-59 year old age group and 60-69 year group compared with census data which had a less extreme distribution of ages. This may have biased any analyses into not finding significant results in the 70+ groups or under 50 year old groups.

In the Census data, distribution across employment groups was fairly consistent (ranging from 20% to 30%) whereas the distribution of the routine SW London data was skewed towards the affluent end of the population. Again this may have biased analyses.

The comparisons above were made between the routine SW London dataset and census data for England and Wales. Whilst it is useful to compare the dataset to a wider national population it is anticipated that the composition of SW London would be different from the census data. The composition of London nationalities is shown below with a large majority comprised of UK nationals. This allows us to be more certain to say the secondary dataset is under-represented by White British women in the analyses conducted.

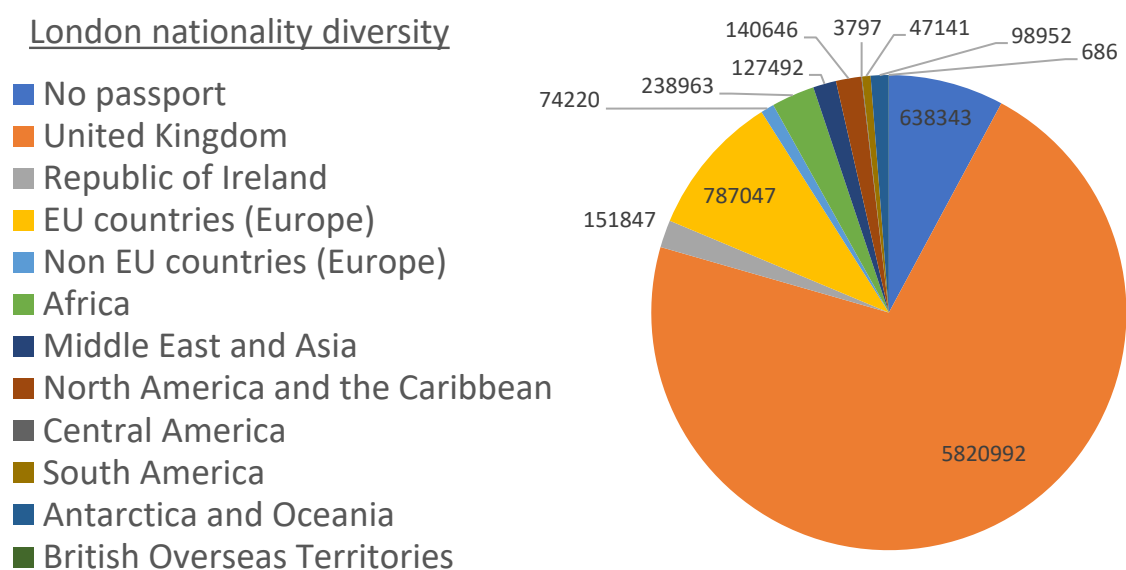


Figure 57. Diversity of nationalities in London population (367).

As discussed above a general decreasing missingness of data has been observed as age increases and is highlighted in Appendix 8.3.6. I cannot be entirely sure why this is the case but it could be due to a number of factors. Perhaps that older women were more comfortable discussing their ethnicity or because older women will have had more opportunities to provide this information as they will have been invited to more appointments and potentially had more opportunity to present this information. Again, whilst there are slight trends in the missingness of IMD data, there is no clear reason why age would meaningfully predict IMD missingness. The association of appointment status with missing data is perhaps about the complexity of the appointment meaning less time and/or pressure to ask about ethnicity or IMD and therefore this information is not obtained. However, no clear reasons or trends have been found and therefore imputation would not be useful. For these reasons, it was appropriate to treat ethnicity and IMD data as MCAR in the final analyses.

4.9 Future research recommendations

When comparing the results of the systematic review with these results it is evident that similarities are present. Uptake appears to decline with older age, increase with affluence and is lower in women of ethnic minority. This is true for attendance at first screening round and throughout. However, despite similarities, the data from the review were found to be not significant at the 95% confidence interval for all the above mentioned outcomes.

It is unfortunate that the routine SW London data did not have appropriate data on other variables such as education, marital status, chronic conditions, housing tenure and number of primary care visits as the review found these to be associated with uptake. Future research should investigate this, perhaps by collecting more detailed relevant data rather than relying on secondary data.

Unfortunately we did not have time to fully develop a model to look at attendance patterns at the first mammography appointment due to the time and financial constraints of the doctoral researcher position. This would be interesting to have analysed as there are perhaps particular sub-groups of women who attend at the first appointment regardless of its convenience for them. In addition it would be fascinating to establish if women who attend at the first appointment are more likely to be compliant with subsequent appointments at the three-yearly interval.

What was interesting and observed in the overall descriptive statistics was that attendance at a first appointment in December was lower than attendance in other months. As hypothesised, general attendance appeared approximately equally distributed across the days of the week. However further investigation needs to be undertaken before drawing conclusions from these observations. Caution needs to be taken as these data do not account for women who needed to re-schedule appointments either due to work commitments, holidays or other reasons.

Much research has looked at the time trends of breast cancer mortality and mortality in women who underwent mammography. To the best of my knowledge little research has analysed time trend data for determinants of uptake to see if these have changed. It is extremely important as a key requirement to achieve cost-effectiveness of the programme that attendance remains above 70%. This analysis has started to contribute to the lack of understanding of attendance patterns over time. However, much more can be done. Ascertaining which women are likely to attend, re-schedule or not attend their first appointment would likely highlight key differences between types of women and therefore more personalised information could be gathered.

Despite collecting the data for screening appointments prior to 2000, regrettably I had to remove them from the dataset due to the reliability of the information. It is therefore

recommended that the issue with the collection of the data be rectified for future use so that a wider timespan of uptake information can then be analysed.

Further research conducted as part of the thesis includes the development of a questionnaire in order to further investigate these predictors of uptake. The questionnaire I developed collects self-reported information about age, IMD and ethnicity. It also collects information about previous attendance, marital status and chronic conditions. These items have been found to be associated with uptake of mammography in the systematic review. Furthermore, the questionnaire provides information to estimate a woman's risk. Once collected it would be fascinating to combine this questionnaire information with the secondary data analysis to understand which types of women are most likely to be at risk from BC compared to who is most likely to attend mammography (or not).

As NHS staff are now directed to collect more data on demographics (including ethnicity) it will be intriguing to conduct these same analyses later using a more complete dataset for ethnicity.

Chapter summary

This chapter has discussed predictors of uptake using a database of appointment attendances for 304,616 women from SW London. It found that older, minority ethnic or women from deprived areas were significantly less likely to attend BCS and women requiring a special appointment or who had had a previous false positive result were more likely to attend BCS than their counter-parts.

This is interesting because previous literature has found that a previous false positive result reduces likelihood of returning, whereas my study suggests false positives may increase the likelihood. (100). Further research needs to explore this interaction.

Screening centres should be informed of the results of this study to tailor their services to the women they are inviting to comply with ethical guidelines. For instance it is positive and reassuring that requiring a special appointment, often believed to be a barrier to attending healthcare, meant they were more likely to attend screening at SW London.

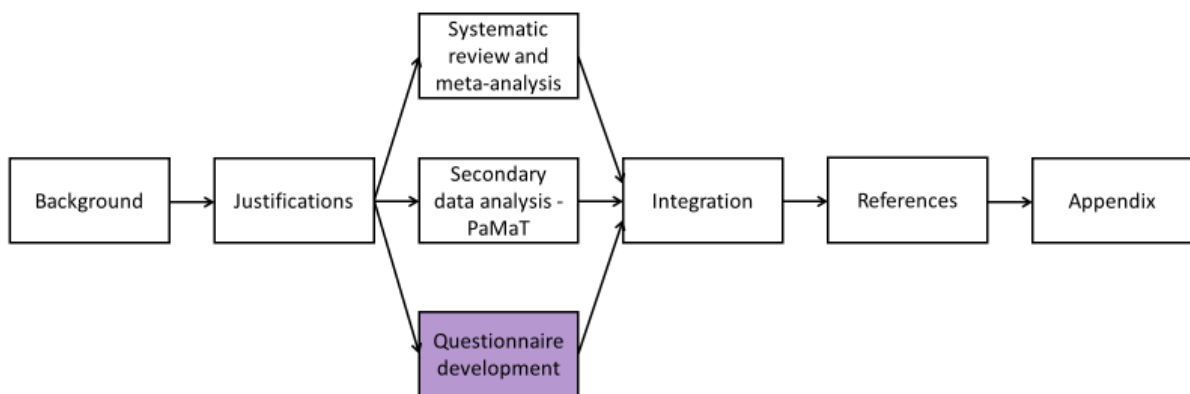
Similar predictors were found to be influencing uptake at the first round of screening except that requiring a special appointment was associated with a lower likelihood of attending BCS.

This research suggests that more could be done by the screening centres to encourage first time attendance in those requiring a special appointment who wish to be screened.

Year was found to be associated with uptake with an overall lower attendance in 2016 compared with 2001, with relative effects of covariates being generally maintained across the two separate year periods. There appeared to be a higher attendance of ethnic minorities in 2016 compared to 2001, but it is unclear whether this is the result of an improved attendance or from changes made to the recording of ethnicity data.

The secondary data analysis has found ethnicity, IMD, age and previous recall to be statistically associated with uptake whereas the systematic review found no significant difference between groups. The integration of study findings will be discussed further in Section 7.2.

The next chapter focusses on the use of individual demographic information and using individual risk of BC data to help encourage informed choice in the uptake of mammography.



Chapter 5: Questionnaire Design

Introduction

As discussed in previous chapters, personal and demographic predictors are positively associated with the uptake of breast screening. The predictors of uptake found in my systematic review to be statistically associated with uptake of mammography included marital status, smoking status, insurance status, chronic conditions and primary care visits. My secondary data analysis also independently identified age, SES, ethnicity, requiring a special appointment and previous recall to be statistically associated with uptake of mammography. The review did not find age, ethnicity or SES to be statistically significantly associated with uptake.

Further research may identify additional predictors of uptake of breast screening in the UK that were not able to be examined in these previous studies. In this chapter I develop a questionnaire to examine personal demographics and predictors of uptake further. Results of these questionnaires will allow the future measurement of associations between personal predictors of BC and uptake. It will also allow researchers to determine which women are making an IC about BCS and whether this is another predictor of uptake. This interplay of predictors and measures is shown below in *Figure 58*.

As no previously validated questionnaires met the criteria for obtaining the relevant information I will begin by explaining the need for this questionnaire. This chapter will explain the methodology of tool selection and elaborate how the questionnaire was developed using patient and public involvement (PPI) and cognitive interviewing.

5.1 Research questions, aims and objectives

The aim of this study was to develop a questionnaire that can be used in future research that will allow researchers to answer the following questions (as displayed in Figure 58):

1. Do personal characteristics influence whether a woman attends/not attends BCS?
2. Does personal BC risk influence whether a woman attends/not attends BCS?
3. What are the characteristics of women who make ICs?
4. What influence does making an IC have on BCS uptake?

However, these questions will not be answered in this chapter as the questionnaire is only taken to the design stage.

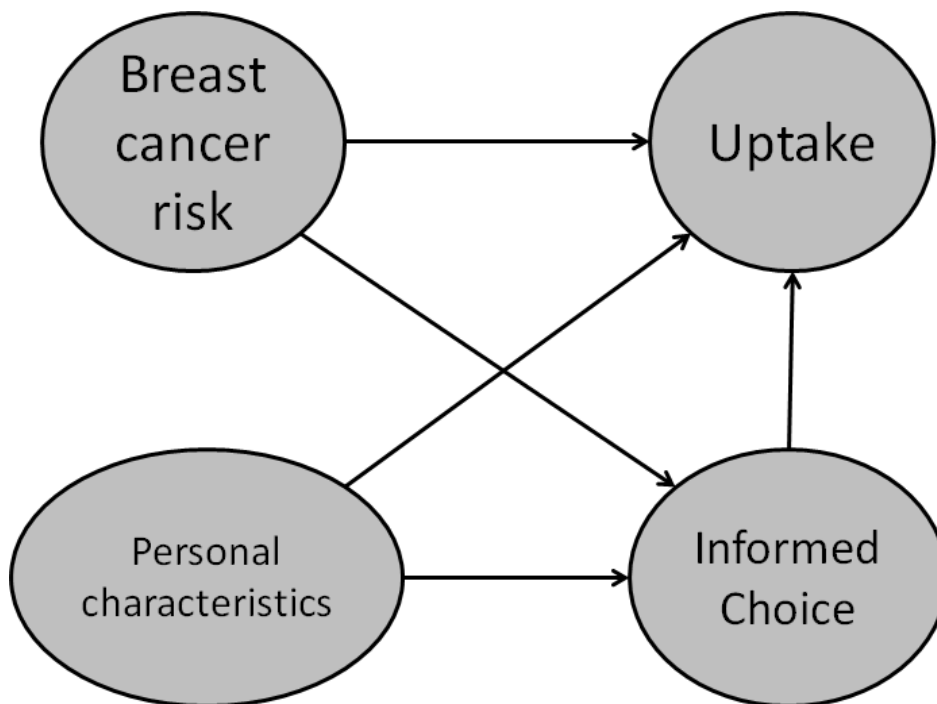


Figure 58. Questionnaire components for analysis.

This chapter describes the development of the questionnaire. A PPI advisor was invited to give their opinions on the length, depth, content and design of the questionnaire and cognitive interviews were conducted that focussed on the following key questions:

- Are there specific questions that raise issues?
- Are there any mistakes or omissions identified in the questionnaire?
- Is the questionnaire appropriate for women aged 47 to 73?

Objectives of the questionnaire development study included to:

- Design the questionnaire to be used at a later stage having obtained ethical approval for questionnaire development
- Write the accompanying documentation including participant information leaflet (PIL) and consent form
- Consult with PPI representatives for advice on writing style, content, layout, order, appropriateness and readability and/or factors to improve likely response rates
- Conduct cognitive interviews (until data saturation) with women within the target age range to ensure the questionnaire is suitable, feasible and asking the right questions

This questionnaire has been drafted for future use. Once fully tested and validated its primary future purpose is to explore the associations between IC, personal BC risk, personal demographics and mammography uptake. The need for which will be described below. Whilst this could just be used for academic purpose (perhaps simply to explore the interactions further or to evaluate a re-designed screening leaflet) it could be used in a screening programme that will need to be adapted slightly for full purpose.

In a screening programme, the new process would involve women being sent the questionnaire alongside the BCS leaflet and asked to complete the questionnaire before posting back to the screening centre. It will not explicitly be stated the answers can be found from the leaflet. Results (levels of IC and personal BC risk) will be used to assess if the woman needs more, specific information to make an IC. This will be tailored to her demographics and personal BC risk. Only if the woman has made an IC then she will be invited (or not) depending on her preferences. If she still

does not make an IC, an appointment should be made to discuss the screening process further with her before making an appointment for a mammogram.

Whilst this proposal contains details that have not been the primary focus of this research, this is the concept and end-goal for the questionnaire.

5.2 Questionnaire design

Questionnaire design involves the development of clear, unambiguously worded questions that allow accurate answers to the question posed (378). However, problems of completion frequently encountered include difficulty with interpretation or comprehension of questions, retrieval of answers, social desirability bias and judgement as to whether the respondent is comfortable disclosing certain information (240). These may result in the respondent failing to answer the question posed, giving obviously incorrect answers, missing questions (or sections) or not following instructions. I aimed to reduce this by including a 'don't know' or 'prefer not to say' option where questions might be uncomfortable for the respondent.

In this section the methods used throughout the questionnaire development process will be described.

5.2.1 The current literature

The current literature was searched to identify potential contributing factors to BCS uptake prior to conducting the systematic review study and found a variety of predictors have been associated with uptake of mammography. Some of these factors were acknowledged as risk factors in the systematic review (see Figure 59) and secondary data analysis also and some are new, interesting and important factors such as the movement towards IC in screening decisions (265, 305, 345). These influencing factors are grouped into health and family history (379), personal demographics and other (380) including attitude towards BC risk or BCS (379, 381) and previous health-related behaviour.

Whilst not all of these were to be included in the questionnaire, key data required for a comprehensive questionnaire were agreed (by the researcher and her supervisors) based on these findings and the relevant predictors and measurements identified were included or adapted for use as recommended (382, 383).

Decision aid questionnaires currently available are not designed or tested for the UK or mammography populations (188). Although it is important to conduct research to investigate the effectiveness of the decision aids for screening in the NHSBSP, the NHSBSP appears far from adopting this practice to encourage IC due to concern over potentially reducing uptake (265). This is despite other countries changing their guidance to adopt IC, for instance in Germany (62). Consequently, assessment of whether an IC affects uptake decisions and if those decisions are affected by personal BC risk or demographics is vital information that the screening programme needs to obtain and be able to prepare for the eventuality that encouraging IC is essential (184, 235).

From this assessment of the literature, three topics were found to be of importance to explore in further detail. IC (as discussed above) is assumed to be associated with rates of uptake and this needed additional investigation. Personal demographics are associated with uptake frequently. It is important to assess the effect of personal demographics in the UK mammography screening population. Finally, IC may reduce uptake of BCS, but it is important to determine if those who are deciding not to attend are those who have higher risk of BC. A risk prediction model was needed to determine this third construct of the questionnaire (10).

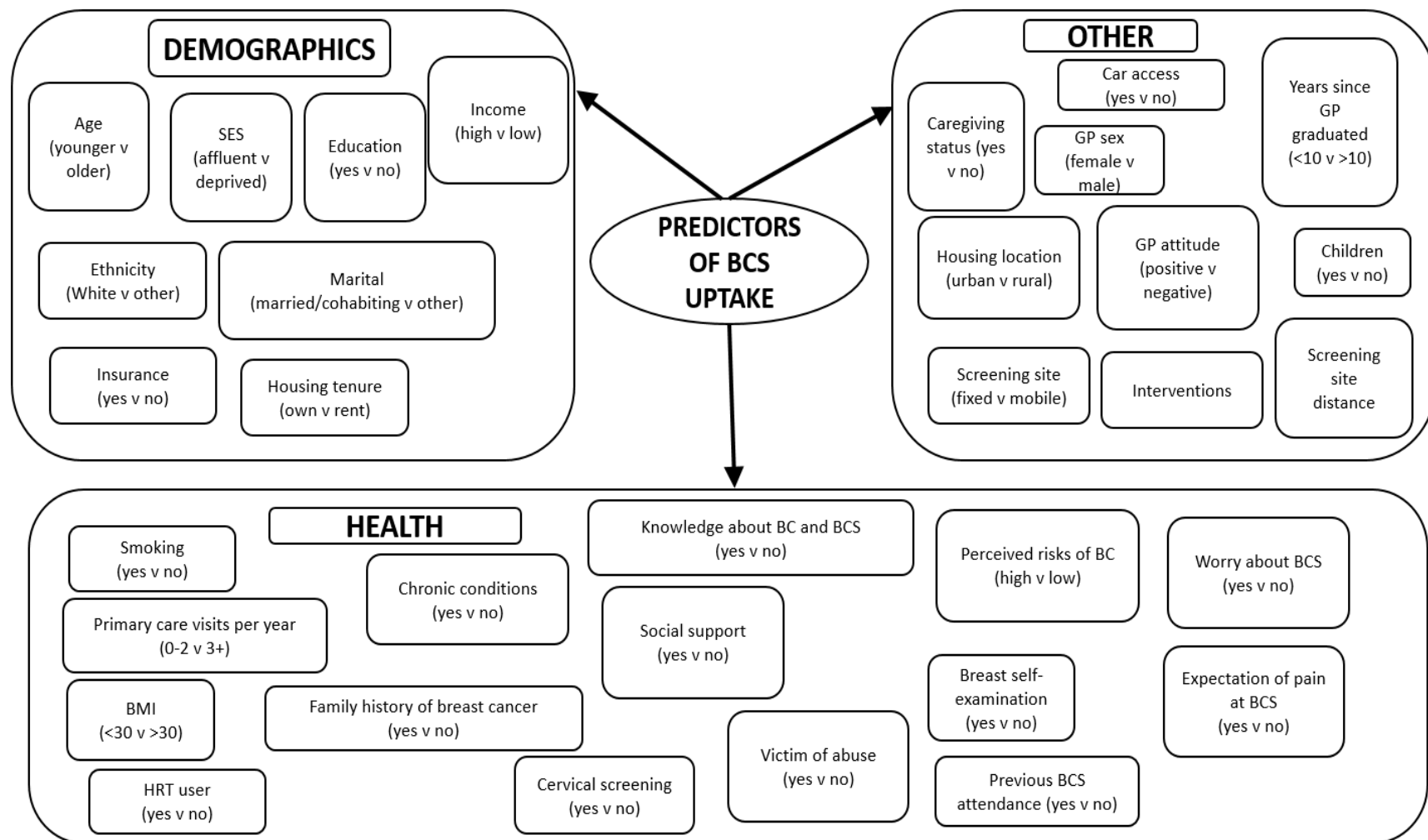


Figure 59. Predictors of BCS uptake (as shown earlier) for reference.

questionnaire

5.2.2 Model choice

Whilst recent research suggests the further addition of factors associated with BC risk such as genetic status or mammographic density, the search for an appropriate model had to align with factors readily available to the population if the questionnaire was going to be effective in the public domain (384-386).

There are over forty risk prediction models that have been peer-reviewed by qualified scientists for use in research and are published in scientific and medical journals (387). Whilst the peer review process is not without its own set of flaws and biases it does encourage transparency of methods, rigour and increases the reliability of the information presented when compared with data that does not come from peer-reviewed manuscripts (388). Eight of these prediction models, which have been independently validated in previous research and are discussed earlier in this chapter.

The risk prediction model for this study needs to be one that is suitable for the general UK population of women of average risk and aged between 47 and 73 years. Those requirements immediately rule out 'Asian Pacific Islander American Women' (389), the 'CARE' model for African American women (390) and the 'Breast Cancer Risk Assessment Tool (BCRAT)' which can predict only for women of those stated ethnicities who are examined annually (391). The Gail model only uses a small selection of the available predictors (age, age at menarche, age at menopause, personal history of breast disease and only first-degree relations with BC) – furthermore the Gail model has been shown to considerably underestimate risk of BC diagnosis which means it has been eliminated for use in this research (392).

The Breast Cancer Surveillance Consortium model by Tice *et al.* was well calibrated but with an observed-expected ratio of 1.03 (0.99, 1.06) meaning that no significant difference was found between the model and real life diagnoses (393). However, the c-statistic (the proportion of pairs where the woman with the disease has a higher predicted risk estimate than the woman who does not have the disease) was lower than other models at 0.613 (0.604, 0.622) and was therefore unfavourable (394). The model is only '*modestly able to discriminate between women who will develop breast*

cancer and those who will not' and the fact the model was calibrated on major race and ethnic groups in the USA means that it is not suitable for use in this study within the UK (393).

Whilst the Barlow *et al.* Risk Estimation Dataset (384) could have been used here, other models had more intuitive interfaces and better c-statistics (the proportion of pairs where the woman with BC has a higher predicted risk estimate than the woman who does not have the disease) a crucial determinant for a risk prediction model. Furthermore the Barlow separated pre- and post-menopausal women into different models which would complicate future research in the design of this questionnaire. Despite this being advantageous as pre-menopausal and post-menopausal women have different risks, the model eventually chosen for our research does account for this factor too but in a different manner.

Two of the remaining options (based on the Nurse's Health Study) are an update of the same model (395, 396). The authors admit an overestimation of risks in certain subgroups such as younger parous women. No c-statistics or observed-expected ratios were provided meaning no comparison can be made and the model will not be used (394).

To summarise, the above risk prediction models have been discounted for the following reasons:

- Asian Pacific Islander American Women' – wrong ethnic make-up compared with UK
- Breast Cancer Risk Assessment Tool – USA data, limited predictor section, underestimation of risk
- Breast Cancer Surveillance Consortium – poor c-statistic, different ethnicities to UK, based on USA data
- Barlow *et al.* Risk Estimation Dataset – unintuitive interface, poor risk estimation
- Two models based on the Nurse's Health Study – admit to overestimation of non-parous women and no available c-statistic or observed-expected ratios

The Tyrer-Cusick (known as IBIS) model

The IBIS model was developed in the UK and combines an extensive network of hormone related, personal and familial risk factors (n=13). A meta-analysis included work by Amir *et al.* (392) who compared some of the available models and found the IBIS to have the highest c-statistic 0.762 (0.700, 0.824) meaning discrimination performance of the model was the best. The expected-observed ratio of IBIS model was also close to one, 1.09 (0.85, 1.41) meaning it is considered a well-fitting model (394).

Moreover, the IBIS model accounts for a comprehensive set of variables including genetic BRCA1/2 factors, environmental factors such as BMI and parity, and hormonal-related factors such as use of HRT, age at menarche and menopause (11). Research has shown that adding mammographic density information would improve accuracy further (397). However, as breast density is not routinely measured in the UK, few women would know their mammographic density making the additional risk factor unusable in a questionnaire setting.

The IBIS model out-performed the Gail model in a cohort whose risks span the continuum of BC risks. However, this experiment was conducted on a US sample and may not be generalisable to the UK population. Despite not being independently validated in the family history setting, IBIS model remains popular and most useful. The area under the ROC was 0.762 (0.700, 0.824) and was the most accurate of all models tested (392).

The decision was taken to use the Tyrer-Cuzick prediction model “International Breast Cancer Intervention Study” (IBIS) (10).

5.2.3 Structure of the questionnaire

The first section (marked A) asks specific questions about medical history to calculate a personal risk of BC. It starts with questions that should be easy to complete and which will not feel too personal for the participants to answer. Section B asks questions to measure individual levels of IC and attitudes towards BCS. Section C asks about personal characteristic, considered by some as mundane, and by others as slightly more intrusive so these were saved until the end of the questionnaire. This

section includes questions such as postcode, year of birth and marital status. This is done after the bulk of the questionnaire following recommendations by Burns *et al.* as initial presentation of demographic questions may dissuade participants from completion (398).

Balancing important questions with encouraging response rates is always complicated in questionnaire design. The questionnaire needed to be detailed to obtain sufficient medical information to enter the relevant information into the IBIS model variables to obtain a BC risk prediction for each woman. Detailed questions about parity, breast disease, family history of cancer and menopausal status are therefore included. Not all known risk factors are included in the questionnaire including many lifestyle factors, such as smoking, alcohol consumption or physical activity thought to be related to BC but are not relevant for completion of the IBIS model (10).

In the aim of reducing repetition of questions which could lead to boredom and attrition, some of this information is found in the personal characteristics section of the questionnaire instead (C) (399, 400).

Section A

This section is designed to allow for estimation of a probability that an individual will develop BC over a given timeframe. Risk prediction models for BC use individual's information on variables known to be associated with BC. Examples include age, family history, breast density, menarche, BMI, physical activity, use of HRT, history of tobacco use and genetics, among others. The risk prediction model used (IBIS) only incorporates data on personal and familial risk factors and does not consider others such as physical activity or history of tobacco use (10). These are factors that are often more well known by the individual and therefore it is anticipated that accurate completion of the questions related to these factors is more likely to be achieved.

Whilst it is difficult to recommend one model over another, as no model consistently out-performs the others on all tests, IBIS has been chosen as it has a high c-statistic, its observed-expected ratio was close to one and it was developed and tested on a population similar to the UK (394). Precise knowledge of individual risk is a

prerequisite for tailored information based on risk. Whilst the risk prediction models need fine tuning, research can be conducted on the use and implementation of such processes ready for when the prediction models improve in accuracy.

Section B

Whilst answers to these questions can be answered by consulting the mammography leaflet, the leaflet will be sent in conjunction with the screening leaflet, but the women will not be advised to complete the questionnaire using the leaflet directly. This will enable a clearer understanding of whether a respondent has the understanding and knowledge, rather than being able to cite information from a leaflet.

Knowledge

As discussed in Chapter 2, IC is measured using a combination of knowledge, attitudes and behaviour (235). *Figure 59* displays this interlinked phenomenon.

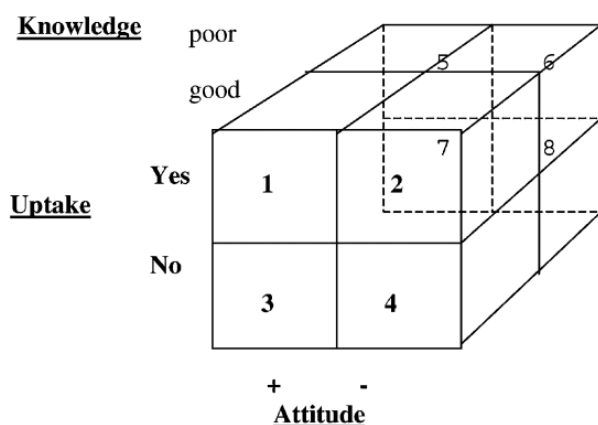


Figure 60. Three dimension of informed choice includes knowledge (good/poor), attitudes (positive/negative) and uptake (yes/no). Combination 1 and 4 are considered informed choices only. Figure taken from (234).

To have made an IC, a woman must have sufficient knowledge about screening and BC and have either (1) a positive attitude reflected by uptake or (2) a negative attitude to BCS echoed by non-attendance at screening (186, 235). Only these combinations are considered ICs.

Whilst that choice may be informed or not, decision making is an essential component of healthcare, not only from the physician's perspective but from the patients'. Primarily, the patient has to determine if they are willing to seek

healthcare. To make this decision (in this instance whether or not to attend BCS) the patient must first decipher the information presented to her before deciding whether or not it is something she wants to do.

The Fuzzy Trace Theory suggests more people rely on gist information compared with verbatim reproduction of the information (194). Gist and verbatim are defined in the same way as in everyday terms, people who recall the gist of the information remember the bottom-line meaning, whereas those who remember information verbatim can remember and recall the specific details (194). Gist information is considered a subjective interpretation based on emotions, education, experience and culture (194). Gist based reasoning is associated with improved health outcomes, increased adoption of behaviours to reduce risk and improved decision making (194, 401). After retrieval of any information however, people assess this against their values and principles before applying it to their situation (194).

Alongside recall of information, health numeracy in terms of judging relative risks and benefits of medical interventions is long recognised as a key component of ensuring an IC. Individuals with a marked lower literacy ability appear to be at a disadvantage. Previous research has found literacy to be connected with greater health knowledge and understanding, expertise to self-manage disease and its treatments and importantly better health outcomes overall (187, 402-406).

It is apparent that health numeracy and both gist and verbatim knowledge are important in any medical decision making. Sufficient knowledge is a key component of the ability to make an IC in a medical decision. In the IC section of the questionnaire it tests both gist and verbatim knowledge, as per the Fuzzy Trace Theory (187, 194). Consequently, there are two types of questions in this section, numerical and conceptual.

The questions measuring knowledge are adapted from work conducted in Australia (164) and the UK (233). As the work conducted by Marteau *et al.* (164) and Dormandy *et al.* (233) investigated Down's syndrome screening and low literacy populations respectively, questions were adapted to reflect BCS in a general population for this questionnaire. Questions used were as similar as possible to increase reliability and

validity by using previously validated questions from questionnaires (407). However these sections would need further assessment during the next questionnaire testing phase.

Attitudes

Likert scales were developed as a five-point bipolar scale in 1932 and are frequently used for assessing opinions or attitudes (408). Using a five-point Likert scale and a scale of agreements to statements, participants were asked about their attitude to BCS. Ethically, questions should be easily interpreted and a five point scale for responses was considered appropriate here (409).

Following research by Dormandy *et al.* (410) respondents with scores above the mid-point are classified as having positive attitudes and those with scores on or under the mid-point negative attitudes. These positive and negative attitudes have been calculated to align with previous research (233, 236). Despite a positive attitude to BCS there may be other factors preventing uptake such as childcare, cultural or logistical barriers.

Section C

The majority of questions regarding personal demographics were taken from the Health Survey for England 2012 as they have been previously validated and published (411). These questions were left until the end of the questionnaire as recommended by previous literature to reduce incompleteness of the survey due to tediousness (407).

5.2.4 Item selection

Discussion between the student and supervisory team were held regarding item selection.

Items were based on similar questions available in the literature as described above. Items were written to be comprehensible to the target population using no jargon and simple sentences. Terms were unambiguous and were specific where possible. Each item only contains one question and remains neutral. All items are weighted equally as each item represents a different dimension.

Items within section A are data that will be entered into the IBIS risk prediction model as shown in Appendix 8.4. All items were written to account for each component of the risk prediction model. Some data for the model are obtained from section C.

Section B comprised a variety of question types to establish the extent of a woman's knowledge about BCS. There were simple questions that asked women to select the answer they felt was correct. These are to be marked as either correct or incorrect. Other questions, namely the numerical ones, required more verbatim recall of information provided in the BCS leaflet. It is anticipated that the majority would be likely to score incorrectly on these (188). However, these statistics are key information which the leaflet hopes to portray and are considered important information which women should be taking into account when making an IC in BCS.

Attitude questions were asked using Likert scales. The use of Likert scales is one of the most frequently used tools (412). The purpose was to understand the opinion of the respondent to the phenomenon of interest (the question posed) and as such their opinion was expressed as the response on the Likert scale (412). The main flaw, as discussed by Jamieson *et al.* is that the intervals between the Likert values are presumed equal and yet are unlikely to be equal (413). Despite this, the response categories have an inherent rank order and as such can be analysed accordingly, in this case with an appropriate cut-off set for 'positive' attitudes (414).

In the final version 'positive' answers were not all down the right-hand side of the page and instead I varied the format to ensure respondents were not biased to one end of the scale. However, providing the middle option as '3' may mean we end up with a lot of neutral responses with no particular opinion. Therefore, attitudes must be more than fifty percent to be considered positive.

Section C is comprised mainly of questions that should be familiar to respondents as they are often presented in questionnaires. They require women to select an option that is most appropriate to their own current situation.

Personal information, not relating to the completion of the IBIS model included partial postcode, ethnicity, marital status, a range of questions related to socioeconomic status (income, employment, education), housing tenure and health

status. These were included based on previous literature searches that indicate these factors are important and associated with the development of BC.

5.2.5 Drafting the questionnaire

What information?

Guidance from Boynton *et al.* was followed throughout the phases of questionnaire design (407). The questionnaire was designed to measure three constructs which could be used in a future risk prediction model. Section A: medical history and factors relevant to a BC risk estimation; Section B: knowledge and attitudes about BCS allowing a calculation of IC and; Section C: personal information.

Is it appropriate?

A questionnaire allows feedback from a large audience with little cost or intrusion into their daily life. The structured, closed questions allow for answers to questions in a less cognitively demanding manner whilst the open-ended questions allow for a deeper, qualitative exploration into the meaning of the answers (415). Questionnaire data generally allows quick analysis using processing software packages but this is minimised with the increased use of open ended questions which require different, qualitative analysis (222, 378). Feedback from questionnaires is generally anonymous (and is in this instance) and therefore the respondents are more likely to be honest with their answers compared with other information gathering techniques such as interviewing where the respondent is in close proximity with the researcher involved (416-418).

In consideration of these points, a questionnaire was considered appropriate to answer these research questions as it is the best tool to use to obtain the large number of responses in a structured manner. Additionally, cognitive interviews were used to ensure that questions were as appropriate and clear as possible.

Is there an existing tool?

There is no single tool that captures data on personal demographics, personal risk of BC, and IC. For some components of the tool, previous research has been conducted.

For example, Marteau *et al.* created a measurement of IC and reported key questions assessing knowledge of the condition and the screening procedure. However, this was conducted for Down's syndrome rather than BCS and therefore needed adapting accordingly (164).

Michie *et al.* have also reported key constructs of the knowledge component of the MMIC model (Figure 59). These included the '*purpose of screening, likelihood of positive and negative findings, uncertainties and risks attached to the screening process and implications of screening*' (234). This model was used to develop the knowledge questions about mammography.

Furthermore, Evans *et al.* have conducted research investigating whether the use of individualised risk in the NHSBSP was feasible and useful (419). This research focused on the incorporation of mammographic density and genetic factors to identify high risk women before exploring the opportunity to counsel them to reduce their risk. Whilst it is acknowledged that using these additional risk factors in the risk estimation model might be helpful, it is unfeasible in this research to focus on those predictors.

Items related to IC were based on the requirements for IC from Marteau *et al.* work, initially conducted in pre-natal screening, as described in further detail in chapters below (164, 233). These items were then validated by Michie *et al.* (186, 234) before being used as part of decision aids in studies about screening programmes by Barratt *et al.* (192). In 2010, Smith *et al.* (188) used the measure of IC in a bowel cancer screening study and Matieu *et al.* (235, 236) adapted it for use in a BCS decision aid tool. These adapted questions have been used as closely as possible in this questionnaire.

The questions relating to attitudes towards the screening test were based on work conducted by Dormandy *et al.* (233). Respondents with scores above the mid-point were classified as having positive attitudes and those with scores under the mid-point as having negative attitudes.

Questions regarding personal demographics were taken from the Health Survey for England 2012, as they have been previously validated and published (411).

How to present the questions

A variety of different question styles were used in this questionnaire. The majority used tick boxes for the respondent to select the appropriate answer or left a blank space for her to fill in the answer (for example when asked how old she is). Rating scales were used to assess a woman's attitude to BCS and to determine her perceived risk of BC. Open-ended questions were used to allow elaboration of negative consequences of BCS, or if there were not any negatives to discuss why she felt this was the case. Other open-ended questions include the opportunity to expand on an answer or to give additional information when an answer is inappropriate.

Layout

The layout of the questionnaire is particularly important. Previous literature has found that low response rates are often due to respondents being unable to follow or read the questionnaire (383, 400, 407). It is preferable that questions are short, concise and straight-forward. However, it has been suggested that sensitive material requires longer question wording in order not to come across as too abrupt (407).

Ethical approval

To develop this questionnaire and conduct cognitive interviews BSREC ethical approval was sought. BSREC approval (REGO-2017-2118 AM010) for the cognitive interviews at University of Warwick was granted on the 3rd January 2018.

Checklist (supplementary material (407))

Boynton *et al.* provided a checklist for the development of a questionnaire (407). The majority of the suggested components of a questionnaire study have been met. The recommendation considered of particular importance was to provide a participant information leaflet for participants to take away after completing the questionnaire.

5.3 Patient and Public Involvement (PPI)

5.3.1 What is PPI?

PPI is the use of patients or members of the public, who are not medically or academically trained to conduct the research to provide their opinion and ideas towards improving the research study. PPI is becoming increasingly common in the

design many research projects to ensure that the research is relevant, effective, focusses on patient needs and is desirable for the NHS (420-422). INVOLVE (an initiative established in 1996 by the NIHR) is a government funded programme to actively support public involvement in the NHS (423).

The process often involves actively collaborating with a PPI advisor throughout the design and development of the initial stages of the study – to ensure the design is effective to recruit as many as required. The role of the PPI advisor is to bring insight, experience in the field of public involvement with research and aims to advance the research, the way it is designed, conducted and disseminated (423).

As part of the CLAHRC team within the University of Warwick I was fortunate to have access to a female PPI representative. She was selected based partly on her experience with the breast screening service and partly for her experience and training within the CLAHRC team. The PPI partner was asked to represent the average citizen who may be invited to complete this questionnaire in the future and to view the questionnaire as a potential screenee. They had not personally had any experience with BC or with a recall result but knew many female friends and/or colleagues who had had these experiences.

5.3.2 Why is PPI needed?

There is a growing body of literature that highlights discrepancies between aspects defined by clinicians to be considered important and those defined by patients as important to them (424). PPI is used as a representative of the patient body in consideration of what is important to include in the questionnaire and how the questionnaire will be perceived by the women completing it. If the questionnaire had little content considered important to the public in a questionnaire about breast screening then perhaps response rate would decrease.

5.3.3 PPI Methods

The PPI representative was provided with a draft copy of the questionnaire and associated PIL and was asked to ensure readability, to determine if questions were acceptable to the general population and to establish whether the questions would provide the desired outcomes. The PPI representative had as much time as she needed to complete this task, there was no time pressure set. The PPI representative

then provided written feedback and suggested changes alongside a long conversation with the researcher about the reasons why and implications of particularly concerning components such as the addressing to the participant familiarly rather than formerly.

A detailed discussion with the PPI representative was had regarding the initial draft of the questionnaire and the PIL. However, despite never being asked to complete the questionnaire themselves through discussion we did effectively go through each question as if it were being completed by a future participant.

5.3.4 PPI outcome and improvements

The PPI representative highlighted a few concerns with the terminology and approach of the first draft questionnaire. Specifically, the PIL was to be made more personable and friendlier; as I was asking for participants' time and contribution to the study I should be addressing them more familiarly. Along these lines I also needed to be referring to myself in the first person, especially as it was I who was conducting the interviews for the questionnaire development.

Importantly, it was to be emphasised that I was not able to provide individual predictions of BC development to the participants. Finally, it was important to accentuate that not all risk factors for BC were included in this questionnaire and that the questionnaire aims to obtain more information about risk factors for BCS development.

Within the questionnaire itself, an additional introductory paragraph with general information was to be added to the start of each section highlighting why these questions are necessary to increase saliency and therefore completion rates (409). A sentence highlighting that I was only interested in the cancer history of blood relatives was also added to the start of relevant questions to serve as a reminder to respondents.

Despite acknowledging that this was not a test, the PPI representative highlighted that it did appear to be a knowledge test. To ensure that participants did not feel as if they were being judged as to whether they had given right or wrong answers within the knowledge section, questions were re-worded so that they reduce the sense that

women were being tested. For instance, a question that was previously worded 'do screening mammograms detect every breast cancer?' became 'do you believe every woman with a 'positive' mammogram result has breast cancer?' The underlying assumption therefore changes from testing the respondent to asking an opinion, whilst still obtaining the same information about the woman's knowledge about BCS.

Acknowledging the limitations of the PPI used

Whilst I am extremely grateful to have had the opportunity to use the expertise of a PPI representative in my research I must acknowledge the limited extent of involvement they had on this questionnaire. I only involved a single PPI partner and some views may have been her own. Furthermore the PPI representative was only involved in a small component of the process, rather than being included throughout the process and in the design and concept of the questionnaire which, with hindsight, may have been extremely useful.

5.4 Cognitive Interviews

Self-report data has been debated for a long time now. *"If there is no certainty on whether survey items are interpreted as intended, how do we assess if we elicit answers to what we really ask?"* [p. 524] (425). Without the confidence of the correct interpretation of a survey question how do we establish measurement validity? Ultimately, that is why questionnaires should undergo rigorous development prior to being distributed.

A cognitive interview is a method of pre-testing the questionnaire on a small subset of the population in order to identify problems, comprehension of the questions and to gain a general understanding how the questionnaire would be perceived to the general sample population. Cognitive interviews are helpful to reduce respondent error in large surveys, to highlight potential mistakes in questionnaires such as inappropriate response options and to establish people's opinions of the questionnaire. Here, cognitive interviews were used on a sample population prior to questionnaire piloting and testing in order to minimise major structural or response errors (240).

5.4.1 Recruitment

Participants for this component were recruited via personal connections as per the ethical approvals in place (Appendix 8.4.4). An advertisement was placed in the Warwick Medical School newsletter publicising the request for recruitment for cognitive interviews. This contained my university email address. If anyone receiving that newsletter was interested in participating in the cognitive interviews they were invited to contact me for more information. At this point I would send them the PIL and ask them to read it and if they were still interested in proceeding with the interview then we would arrange a mutually convenient appointment with which the interviewee was content with.

At the appointment I provided them the PIL again and a consent. Informed consent was collected after the participants had had time to read and digest the PIL and ask questions.

It was anticipated that a sample size of twenty would give enough likelihood of detecting problems with the interview given that they were not considered complex questions and that previous research suggests a sample size of 20 would identify approximately 100 problems with the questionnaire (426). Thirteen participants were interviewed. This was fewer than the twenty planned because data saturation had been reached.

5.4.2 Interview

The cognitive interviews comprised semi-structured interviews alongside completion of the draft questionnaire with the intent to identify problems with the questionnaire that might arise in prospective research (240). A major component of the interviews was to ensure that participants understood and interpreted the questions in the same way as the researcher did (427). For example if a question is interpreted incorrectly by all cognitive interview participants the issue can be rectified before the next phase of the questionnaire (382). Another priority of the cognitive interview

phase was to ensure that the questions were correctly designed and that all potential answers were accounted for.

Despite a higher respondent burden, the participant was asked to concurrently 'think aloud' for the purpose of the interview to encourage participants to explore their answers (240, 427). At the start of each interview, the researcher prepared the interviewee by saying the following: *"This is a questionnaire that I am developing as part of my thesis to identify different predictors of uptake in breast screening. I'm interested in what you're thinking while you're responding to the questions and what you understand the meaning of each question to be. So, I'm going to ask you to think-aloud as you answer each question in each section. Please complete the questionnaire and think aloud as if I'm not here. You might think about things that aren't directly related to the questions and that's fine. Don't worry if anything doesn't make sense to you, we can talk about it after you complete the questionnaire."*

This method allowed the interviewer to obtain detailed notes and insight into the respondents' cognitive process when answering questions. However, when this provided insufficient detail, pre-planned scripted probe questions were used for anticipated difficult questions to obtain missing information (237). Spontaneous concurrent and/or retrospective probes were used where necessary and were helpful as they allowed exploration of unexpected reactions (240).

Probes such as 'what does that question mean to you?' or 'what does the term screening mean in this question?' were used to investigate topics such as comprehension of the question; 'how did you get to that answer?' for retrieval of information; 'was this easy for you to remember?' for confidence in the answer and 'did you feel comfortable answering that question?' to check for respondents' embarrassment or difficulty with a particular question as suggested in previous work (382).

Interviews were conducted face-to-face only at the University of Warwick except for two which were conducted in a neutral environment. Interviews were audio-recorded (where permission was granted) and additional notes written where

necessary. I interviewed, transcribed and analysed all data collected at the interviews.

One of the purposes of the cognitive interview is to explore issues that may appear from any stage of cognitive processing: reading; comprehension – the process of making sense of the question and developing a response; interpretation – is the interviewee understanding the same thing as the researcher; memory retrieval – of relevant information to enable a response; formulation of answers – whether the interviewee feels it appropriate to provide that information; and judgement - to determine if memory retrieval is accurate and complete (428). This relates to the analysis section which shall be discussed later.

There were minimal inclusion/exclusion criteria associated with the cognitive interview. Simply, the participants had to be female, within the age of 47 to 73 and have received at least one invitation to mammography screening. Of those who participated, all were aged between 50 and 70 years, were White ethnicity, one woman had previously been diagnosed with BC and one woman had a significant family history of BC in her family. The mean duration of the interviews was approximately 25 minutes with a range between 13-45 minutes. The longest interview was for the woman who had a significant family history which is logical as she had more detailed questions to answer than the rest of the cohort.

5.5 Qualitative Analysis

One person was responsible for all analysis and coding of the qualitative data.

A deductive approach was taken to look for similarities and differences between the data. Transcripts were coded to be grouped and compared with other similar or related pieces of information. These were then assembled into themes or categories.

The analysis process was a circular, iterative progress. Text summary methods were used to describe dominant themes and problems identified within the questionnaire using the researchers observations throughout the interviews (429).

Conventional content analysis was used for the purpose of classification, summarisation and tabulation of results (430). It meant the data were described for

what it contained and suggestions for future development of the questionnaire could be made using participant data rather than pre-conceived ideas from the researcher. Codes were derived from the data during analysis. This helped reduce bias.

Data were organised into six domains as below. These closely resemble the important stages of cognitive processing.

- | | |
|------------------------|--|
| 1. Structural | Any comment about the physical structure or organisation of the survey, e.g. skip instructions, ordering or questions |
| 2. Recommendations | Any recommendations suggested by the participants |
| 3. Sensitivities | Any comment that suggests that questions are insensitive or that they might elicit inappropriate feelings or emotions |
| 4. Response difficulty | Items where there were insufficient answer options for the participant's response |
| 5. Linguistic | Any indication of problems with comprehension of the question or interpretation of word meaning |
| 6. Cognition | Any issues arising in relation to the mental act of acquiring the knowledge or information used to answer the question and the process involved in recalling the information in order to answer the question |

5.6 Results

Two early interviews identified a vital mistake in the drafting of the questionnaire in that there were not appropriate responses to the menopause question. This was noted and altered after the first two interviews to improve ease of completion for the rest of the interviewees as suggested by Levin *et al* (431).

Key quotes were identified in the transcript before being combined into an overall summary for each questionnaire item. An analysis table was created that summarised the interviewer's perspective of the interview, using quotes from interviewees and another column highlighting whether this finding was found consistently or not. This is provided below.

Table 21. Content analysis and researcher summary of interview transcripts. The question topic is provided in the first column. The full original draft of the questionnaire is provided in Appendix 8.4.2.

Question Number/Topic	How the item performed overall from the interviewer's perspective	Quote	(In)consistency
Introductory paragraph	Most women would admit it was too long and they skipped reading this.	"[I didn't read it as] I've assumed that's included in the participant information leaflet" (B)	Most women did appear to skim read the introduction section to the questionnaire "it's a little long" (M)
1 Height	Most women answered in feet and inches but liked that there were options for both depending which you preferred	"I'm glad you've got feet and inches because I saw centimetres and was like ooo" (H)	"I know what it is in...oh yeah so feet and inches" (I)
2 Weight	Answers were commonly estimated. This question may appear quite sensitive to some	"I'll estimate about 11 and a half stone" (C) "ooo a personal question" (J)	"People will always underestimate what they weigh or round down. I don't know, they might do" (D) "I'm thinking do I give an honest answer" (G)
3 Pregnancy	Some identified that the question does not specify between miscarriages or number of pregnancies. It was simple to answer for most.	"or would you say 'have you had any children'? I guess 'have you given birth' allows for any miscarriages. Or would you want 'have you been pregnant'?" (J)	
4 Age at first birth	Generally well. There was a minor response difficulty identified as	"So, I gave birth to twins so the question should read children not first child" (D)	No difficulty in answering the questions but it does spark a query about why this

Question Number/Topic	How the item performed overall from the interviewer's perspective	Quote	(In)consistency
	the question does not account for twins. Some cognitive difficulty in recall.	"Erm she was born in 1994 so... these are taking me a minute to remember, but other than that I am over 50 so it is a long time ago. But I don't find them difficult and I don't find them over-intrusive or anything like that" (E)	question is being asked in relation to breast cancer: "I'm just thinking does that have relevance obviously to breast cancer" (A)
5 Age at first menstruation	A lot of inconsistency about whether this information was easily recalled (and accuracy of recall).	"Period information is easily recalled – my mum was crying that 'this is it for the rest of your life'" (K) "I have a very good memory of that" (M)	"I don't know how old I was...I'm gonna guess I was 13" (F) "...difficult just because it's such a long time ago. I can't be precise but I think it's about that." (C)
6 Date of last period	Some response difficulty with answer options was witnessed. It appears some women have clear recollection and some women do not.	"So I'm going through the menopause so it has been a while since I had a period but because I'm on HRT I do have a regular monthly bleed with that but it's hormone induced. I will put last month but so long as you're aware of that" (J) "I think it was an answer that doesn't fit within those options as it was more than two years ago" (B) "We're now perimenopause you see so we have a period and then a week later you start so next one...I guess that's within the last month isn't it" (L) "I can pinpoint because of my age, it becomes rather significant that I haven't gone a year yet" (M)	"Oh goodness gracious (sighs) err...let me see. Gosh. Right. I'm nearly 59 so I think it's more than five years ago" (G) "How old am I now? (laughs) need to stop and think. Probably about 52" "I'm just trying to think, it's difficult to remember accurately but probably the first signs of it were a good few years ago when periods come and go well a bit more sporadic to the normal routine" (H) "You just forget really because it's such a long time ago and of course obviously when you start the menopause you don't know that's going to be your last period so you don't take any sort of note of it...so when people ask me I think ooo it was

Question Number/Topic	How the item performed overall from the interviewer's perspective	Quote	(In)consistency
			round about this sort of time but I can't remember" (A)
7 Age at menopause	The definition of menopause caused some difficulty. Another issue was about the recall of information. Two women found skip instructions confusing (from question 6)	<p>"this depends on their definition of the menopause" (D)</p> <p>"how old were you...errr that's difficult to pin point the start of the menopause...because it's very gradual. Looking back you think oh that was probably the start of it...didn't realise at the time but looking back" (G)</p> <p>"Right so I miss this one out? It presumes that I'm going through the menopause if I haven't. That wasn't clear." (I)</p> <p>".....oh right so that's not applicable is it" (L) [missed skip instruction]</p>	<p>"yes it's good to have it right next to the question" (C)</p>
8 Use of HRT	Response difficulty for a woman who had had breast cancer treatment. Another thought the potential answer may induce anxiety in some women.	<p>"I had breast cancer treatment at 50 years old so HRT isn't an option for me" (K)</p> <p>"I'm thinking how is this relevant" (A)</p>	<p>This was only identified by one participant who had had breast cancer treatment.</p> <p>This was only a concern for one woman.</p>
9 Date of HRT use	For women that have used HRT this did not provoke a reaction – either positive or negative. Comprehension of HRT	"HRT is HRT. Unless you want to define it even more and say a medical one or a bio whatever they call it one" (M)	

Question Number/Topic	How the item performed overall from the interviewer's perspective	Quote	(In)consistency
	was sufficient for this question.		
10 Length of HRT use	Same issue with recall but did not appear to be as much of an issue, potentially as it is more recent.	"I think I've been on it two to three years, yeah I'll say three years" (J)	
11 Previous diagnoses	Definition and therefore understanding of terms was a common issue shared by all. Instructions could have been clearer. Should clarify that the question is asking about breast biopsies.	<p>"I don't know what they are" (D) "I don't know what they mean" (H)</p> <p>"it made me re-read this question, that's all. For me if none applied I wouldn't be expecting to tick a 'no' box" (C) "So tick, I don't need to tick any of them. Actually if they were on the same page maybe I'd have skipped down and seen breast cancer" (E)</p> <p>"So all these things you're asking people if they've been diagnosed with is this any biopsy or breast biopsy" (D)</p>	This was identified by almost every woman interviewed as an issue. "I know I haven't been diagnosed with any of these as I would know that but I don't know what they're related to" (E)
12 Family history breast cancer	These items appear to perform well. However, they can only capture information about relatives that is known to the participant. The tables appeared to confuse some people	"Not ones [relatives] I've known anyway" (G)	
13 Details		<p>"what do you do if you have multiple relatives" (D)</p> <p>"Only because I'm assuming only on what my mum told me...Mum is of the era where you don't talk" (M)</p>	"I do know that partly because I've been doing a lot of family tree searching so I know what they've died of" (J)

Question Number/Topic	How the item performed overall from the interviewer's perspective	Quote	(In)consistency
	(although they did not have to complete it).	"trying to think now isn't that awful. I've got a massive family so this is actually quite hard for me" (A) "I might not know to be honest" (A)	
14 Family history BRCA1/BRCA2		"I don't know what they are other than they're a link to breast cancer" (B) "Explain the terms" (K)	"I know what those two genes are but it maybe needs clarifying again"(E)
15 Details		"Why have you suddenly asked about male relatives now? Seems a bit weird" (D) "You're asking people to do this anyway I guess the question is whether it's worth capturing how many people had a male relative and it gives them the opportunity to fill that in so they don't feel excluded" (D)	Only one woman identified this as an issue
16 Family history ovarian cancer		"So I get to skip to question 18 but then I need to read the previous section" (E)	
17 Details		"It was all shrouded with secrecy" (D) "This is presuming people tell each other" (I)	This has been identified for previous questions also
18 Screening use	Options not suitable to some women.	"I'm just re-reading the options because they're not what I would have put...I was expecting to see the definition of screening there as an option" (C)	"I think to give an answer about deserving treatment is bizarre. It might put into people's minds that this could be the answer. I find it a bit odd." (D)
19 What is screening for?	Most women answered with no issue. However one guessed rather than saying 'don't know'	"I really don't know. I think I'll say maybe C) it means she does not have cancer that can be detected" (F)	

Question Number/Topic	How the item performed overall from the interviewer's perspective	Quote	(In)consistency
20 Positive result meaning	Item performed well in general. One woman did not know.	"No because they do say that in all the leaflets that if it's positive don't panic" (H)	"I honestly don't know the answer to that" (C)
21 Negative result meaning	Answers did not seem appropriate for many women.	"hmm...see I would say it means not that she doesn't have cancer that can be detected at the moment but that it's not thought that she has cancer that can be detected at the moment. Because actually it could be a false negative" (D) "I mean they're not usually confirmatory so to check for signs of suspected cancer. It's not confirmed by the mammogram it's confirmed with the pathology" (J)	"I suppose could there be an option 'she does not have cancer' full stop" (B)
22 Highest breast cancer detection	A lot of women struggled to answer this question.	"I don't know. That's slightly ambiguous. I don't know, I don't really understand that. I don't know why one of them would be higher than the other." (I)	"I was thinking initially when I read it I was thinking which groups do you believe have the highest rates of BC detection whether that was going to be a general so smokers or non-smokers that kind of thing" (E) "I know it happens but I have not got a clue on the amounts. I know there are positives negatives if that makes sense but I really don't know the statistics" (M) "I think I'd tick don't know because I really don't know the percentages" (M)
23 Overdiagnosis rates	A lot of women struggled to answer this question.	"I honestly don't know, haven't got a clue" (G)	"I'm thinking it's a test and I should know this" (A) "oh gosh I really don't know that [re-reads question] no I don't know that at all" (L)

Question Number/Topic	How the item performed overall from the interviewer's perspective	Quote	(In)consistency
24 Negative consequences	Most women appeared to have a stable opinion and answered the question easily.	"I've read that and I think it depends what you mean by negative consequences" (A)	"For me there aren't any. But I suppose there may be negative consequences of having an x-ray. There may be negative consequences in that people get anxious about it. But I don't so I'm trying to think from my perspective. No." (B)
25 False positive rates	Item appeared to be answered easier than the previous 'numbers' question	"I would say....[pause] hmmm...how many...oh right I need to read that again...[reads again] so what percentage? I would say about five. Oh I really don't know. I'm going to guess" (E) "Don't know the answer to that one" (D)	"Now funnily enough I think I might, whereas the other one I didn't know the percentage on this because I've got friends who I know, if that makes sense, I'm going to say ermm I'm going to have to guestimate at C" (M) "See here I'd say it's 1 in 4 do have or would have cancer detected so that's about 25% isn't it" (C)
26 Is screening compulsory?	One woman was confused about the question meaning.	"is that asking if the government are insisting or is that me thinking that it should be" (M)	No-one else appeared to have an issue with understanding the question was asking whether the screening programme was compulsory for them to attend
27 Attitudes to screening	Some of the opposing options didn't quite match women's opinions or expectations.	"That's an interesting question as you're willing to go because you feel you have to do it...I'm not sure they're two opposites" (A) "Something I feel I have to do and I'd be willing to go. They don't quite match for me. So the opposite or that would be something I don't feel I have to do. So I'm definitely willing to go but it's not quite the	"I don't want to put the middle option though" (C)

Question Number/Topic	How the item performed overall from the interviewer's perspective	Quote	(In)consistency
		same as saying...because the opposite to that would be I don't feel I have to go." (E)	
28 Previous use of screening	Loose interpretation of the timescales identified in one interview. This could happen frequently.	"PPTT: probably just over three years RESEARCHER: why did you tick no there? PPTT: because I hadn't done any of the above RESEARCHER: but you said it's been more than three years since your previous one PPTT: but only slightly" (L)	
29 Recent use of screening	Most women correctly identified the question was about a previous mammogram.	"now that 'a previous breast screening appointment' is that the same as a mammogram" (A)	
30 Delayed or rescheduled?	Women have different recall capabilities about these events.	"I haven't done any of the above I can relate that to my experience quite happily" (E)	"I don't think I have but then I've been having them since I was 50 so my minds gone a bit" (M)
31 Attitudes to screening	A few women had difficulties with this question – what it was actually asking and also with some of the options.	"I don't know if receive is the right word...when I first read that then I thought oh it's about when I receive a notification to have a mammogram" (A) "I'm comfortable in terms of being with the staff. But I'm uncomfortable in the sense it's physically a bit uncomfortable" (E) "does that mean physically uncomfortable or that it's a procedure?" (L)	"For this one I'm thinking do you mean when you receive it or when you attend the mammogram and have the actual...because I'm thinking is that the invitation in which case I'd feel that's different to actually going along" (E)
32	Women either found it difficult as "it's not	"who knows? It's not something you can predict" (F) "that's quite difficult isn't it" (A)	"If I had a family history of breast cancer or knew more people with it then I'd

Question Number/Topic	How the item performed overall from the interviewer's perspective	Quote	(In)consistency
Risk of breast cancer in five years	<p>something you can predict" or they used known risk factors to estimate using their best knowledge.</p> <p>Most women didn't like to be too optimistic and commented that you could never know.</p>		<p>probably feel differently. I don't think I'm invincible I just think there's probably other things that will get me first. But you never know do you" (C)</p> <p>"on family history I'd say unlikely but then I don't know on the sort of me bit I have no idea. I'd say (pause) I'd put it at a two maybe" (L)</p> <p>"in my mind it's what are the risk factors" (A)</p> <p>"I have other cancers in my family that might make me think more but breast cancer...I don't have any blood relatives that have had it so probably in the next five years pretty unlikely. Most women are older when they get it anyway." (E)</p>
33 Risk of breast cancer in lifetime	Again, women either were hesitant to "tempt fate" or used known risk factors to estimate.	"I guess the longer you live the risk of developing breast cancer is more likely. I'll just put the middle one again as I'm not sure" (I)	"again I'll put a two largely on the family history side of things...it's so difficult to quantify it. Because you don't feel like you want to say unlikely because it's almost like tempting fate. And it's what you base it on. So far as I know, going back to grandparents there hasn't been a single relative who has breast cancer and all family members are ok and most are older than me. So logically you think I

Question Number/Topic	How the item performed overall from the interviewer's perspective	Quote	(In)consistency
			must be relatively low risk but you think ooo with the lumpiness and over the years I've had a few checks makes me uneasy about it" (L)
34 Date of birth	Structural issue with the questionnaire.	"You cannot promise someone if you've asked for their date of birth and postcode that this information will be anonymous. You keep assuring them but it's very identifiable data...could you not just have their year ...or you can simply ask how old people in brackets...and first three parts of the postcode?...I would get cross with you if I saw that and I was filling it in as I'd just think you were lying" (D)	One woman found an issue with the anonymity of the questionnaire
35 Postcode			
36 Ethnicity	No reported issues.		All my participants were from one ethnic group however.
37 Marital status	Preference of answer options.	"I hate it, I'm divorced but if you ask me I say I'm single" (D) "This annoys me. Why can't people just be going out with someone? Why do we have to say we're single when we might have a boyfriend?" (D)	"I'm currently single. Oh wait, I'm divorced sorry. I forgot about that" (J)
38 How occupy accommodation	Preference of how to ask the question in the simplest format.	"So that's me and partner...so I'm quite happy with that. I like those categories actually, I like the last one [laughs]" (E)	"I think I'd rather say it like 'how would you describe your living arrangements' and then give the options" (J)
39 Education	No reported issues.		
40 Employment	Some reported issues with answer options.	"You haven't got an option for education" (D) "I think some people might like to be able to say they're employed but they're also a carer because	"I think you should combine question 40 and 41 and have a 'tick all that apply'

Question Number/Topic	How the item performed overall from the interviewer's perspective	Quote	(In)consistency
		some people also care and look after a home and family. Someone's working part time maybe. Maybe you put an option" (I)	question so they can fit into multiple boxes. Maybe over the last year" (D)
41 Employment	See above – questions to be combined in future questionnaire.	"I don't know I could tick all of those to be honest. I'll just go self-employed because of [name of partner]" (M)	
42 Income	Definition interpretation of 'take home' confused one woman. There may be a cultural appropriateness issue of asking about income but this was only raised by one woman.	<p>"It's difficult because my partner's income is variable, but it's usually around that" (K)</p> <p>"[researcher: would you be comfortable stating that on a questionnaire?] PPTT: yes because I'm not specifically stating how much we earn" (B)</p>	<p>"So take home is the right phrase but some people interpret it better. I could tell you my top line not my bottom line" (D)</p> <p>"what is this gotta do with you doing...I don't get that. I think you doing this, it'd piss a lot of people off you having that in there...I just can't see the relevance of you doing a survey on breast screening asking that sort of question. Yes age, health, married and working...but what's salary got to do with it? It's totally irrelevant to me" (F)</p>
43 Illnesses	Most women were unsure how to answer this by the time they'd read question 44.	"I answered no without looking at the options. If I'd seen the list before the question I might have thought oh well I sometimes do have a problem with my memory" (C)	<p>"I think you should combine question 43 and 44 and just have an option 'none of the above'. That way no-one would skip over it accidentally. (D)</p> <p>And it might focus people's minds. They might not realise what types of conditions you're thinking about until you ask them that they might not think about and might</p>

Question Number/Topic	How the item performed overall from the interviewer's perspective	Quote	(In)consistency
			have missed. I'd also specific [specify] for the partial sight 'not correctable by glasses'" (D)
44 Health conditions	Comprehension of question answers.	<p>"[re-reads] well actually I have I don't consider it to be...well I guess I do...I am partially sighted, I only have sight in one eye but I don't consider myself to be visually impaired" (I)</p> <p>"I suppose the reason I've gone on to this question is chronic pain in back and neck as it affects me but not in these ways in daily life" (B)</p> <p>"I have partial sight, I wear reading glasses, but I'm not sure that constitutes it" (A)</p> <p>"Do you count partially sighted as I wear glasses? (L)</p>	<p>"Oh maybe I should have read that question first" (C)</p> <p>"I've got an underactive thyroid. So I put that as a 'yes' [previous question] but then the things you've got here are... [putting me off] because the things it causes isn't listed so it makes me think have I done it wrong. I suppose fatigue is included" (H)</p> <p>"I must have read that wrong. I think it would probably be better to read the conditions listed before ticking the box saying that it affects you" (H)</p> <p>"perhaps swap them [questions] over and say 'do you consider yourself to be struggling with any of these things' and then ask 'do they affect your work life, your home life, your daily activities' (I)</p>

A general observation was noted by the researcher that where questions slipped onto a subsequent page there was much page flipping back and forth which appeared to distract multiple participants. This has been rectified in the updated draft.

Subsequently, an ‘action’ point table (*Table 23*) was created to highlight problems identified with each item and what action was appropriate to take. The justification is in the final column. Revision of an item is not based on the number of times a question was considered problematic but the nature of the problem and a logical judgement was undertaken.

Table 22. Action point summary

Question Number	Problem identified	Action to be taken	Justification
Introductory paragraph	Women skipped the introductory text as it was too long	Make it more concise	To be read by more women.
1 Height	None – women liked that there were options for feet and centimetres	None	Doesn’t take too much space on the current questionnaire to have both options
2 Weight	Women are likely to estimate the answer if they believe it too personal or if they genuinely do not know a precise answer		
3 Pregnancy	Miscarriages or number of children not asked	Unsure	To ask if a woman gave birth only to a live foetus could be upsetting to the participant. The risk calculator only asks about the woman’s parity.
4 Age at birth	Twins	Change the wording to include the birth of twins	Simple and easy
5 Age at first menstruation	Some women found this information easy to recall, others did not and had to estimate	None	Cannot make this question any easier to recall. Women either know this information or not.
6 Date of last period	Response difficulty with appropriate answers	Additional options added. Need to add an HRT-induced monthly bleed option	

Question Number	Problem identified	Action to be taken	Justification
7 Age at menopause	Definition of menopause may be different for each woman and therefore they could be answering different questions	Either add a definition of menopause (“You might want to have a free text that says what is your view? What was the trigger for the start of menopause for you?” (D)) to the question or add another question asking about their trigger for menopause or ask about their definition of menopause.	Adding a definition would likely be simpler but you cannot ensure that everyone reads and understands it. By asking women to complete a subsequent question you can base their answer on this information.
8 Use of HRT	An additional answer box is required	Add “HRT isn’t an option for me” as an answer	For women who have had breast cancer treatment they do not have the option to use HRT.
9 Date of HRT use	Recall	None	
10 Length of HRT use	Recall	Answer options should be changed to grouped answers such as 1-6 months, 6-12 months, 1 year, 2 years, 3 years, 4 years, 5+ years.	Some women may not have used it for a year so the current option to have X years is inappropriate. Having the grouped answers may make it easier to recall in which category they belong rather than the exact amount of time.
11 Previous diagnoses	Definition of terms Instructions and structure Clarify asking about breast biopsies	Clarifying ‘breast biopsies’ is simple quick and easy. Fibroadenosis needs to be added. Define terms. Change ‘no’ to ‘none of these apply to me’. Ensure all the options are one page so a woman can easily scan the answers	Definition of terms should go on the same page but needs to be in layman terms.
12 Family history of breast cancer	The question can only capture information that is known to the participant	None	
13 Details	The question can only capture information that is known to the participant	Make it clearer in the table how to complete it with multiple relatives: “I’d put a line in and probably leave a couple of lines as they might have more than one sister” (D)	Use the term ‘both breasts’ rather than bilateral because “‘Are people likely to know what bilateral breast cancer is? The same with genetic testing” (I)’. ”

Question Number	Problem identified	Action to be taken	Justification
		"Bilateral means both breasts? Why not just say that?" (D)	
14 Family history of BRCA1/BRCA2	The question can only capture information that is known to the participant The term BRCA1 and BRCA2 need explaining	Explanation of the terms in layman English needs updating as identified by multiple participants "Explain the terms" (K). I will add to the question further instruction about how to complete: "You could add 'please only tick no if you definitely know you haven't had it" (D)	By adding 'please only tick no if you definitely know you haven't had it' means I can be confident about their answers.
15 Details	An error has been identified in the questionnaire	Male relatives (father and brother only) should be added to the breast cancer table (question 13)	There are options to enter this into the risk calculator and therefore should have been included in the questionnaire.
16 Family history of ovarian cancer	Skip instructions	Make the instruction 'skip to the next section KNOWLEDGE ATTITUDES AND BEHAVIOUR' rather than question 18	In order to encourage reading of the introduction text
17 Details	The question can only capture information that is known to the participant	None	
18 Screening use	Two women did not approve of the answer options	None	Most women clearly understood the answer options
19 What is screening used for?	People guessing rather than selecting the 'don't know' option	Add a 'both' option. Define 'population screening'.	Allows for more precise answers
20 Positive results meaning	Different thought processes, ranged from don't know to definite answers to even more accurate than the options	No need to change anything.	It is acceptable for a woman to tick 'don't know' when she really doesn't know

Question Number	Problem identified	Action to be taken	Justification
21 Negative results meaning	Most women identified that the answers were too concrete compared to what the screening results letter would say	Need to add 'to the best of the screeners knowledge' and/or 'that can be detected at this time'	It is fair and appropriate to add this in. No screening result is 100% confident.
22 Highest detection rates	A few women commented that this was a good question	None	Despite a lot of women feeling ambiguous or confused by the question, it does ask what I need it to ask and to answer 'do not know' is an acceptable answer.
23 Overdiagnosis rates	Women did not know the answer. They also felt like it was a test.	Change the options to 2/5 or 4/5. Emphasise that this is only breast cancer.	Justified as other women suggested this change too: "I'd have guessed at 2/5 or 3/5" (D) "So does this question refer to all cancers? Or just breast cancer?...because I'm immediately thinking of all cancer" (E)
24 Negative consequences	Confused responses by women who ticked no.	Comprehension of negative consequences should be explored further in a subsequent question.	Further exploratory work needs conducting on this as many women would tick 'no' but then go on to qualitatively describe the negative consequences I was originally thinking about when writing the question. Answers were made clearer 'yes – there are negative consequences' and 'no-there are no negative consequences'
25 False positive rates	The answers were split. Some women still did not know and found it hard to work it out. Others based it on their personal experience with friends and family	Follow up with further questions in questionnaire exploring their baseline – i.e. their experience with friends and family and breast cancer and screening (see other comments)	In order to understand where a woman is basing her judgement it is interesting and important to understand her influences. This would benefit other question comprehension too.

Question Number	Problem identified	Action to be taken	Justification
26 Is screening compulsory?	Comprehension issue	Elaborate that I am asking if breast screening is something that is compulsory (by the government) for you to attend	Otherwise this may be influenced by a woman's opinion of breast screening and that she may believe it's compulsory in order to 'not miss' a cancer.
27 Attitudes to screening	Problem with the opposite ends of the scale	Something I feel I have to do Something I feel I don't have to do	Most women picked up on this point so it is justified to change it
28 Previous use of screening	If interviewee is dishonest then there is no way of determining this on the questionnaire	Nothing that can be done. Have to rely on trustworthiness Add 'screening' mammogram to the question	Adding 'screening' mammogram is likely to make the question less ambiguous
29 Recent use of screening	Problem with interpretation of terminology	Change 'previous breast screening appointment' to 'previous mammogram'	This change is likely to make the question less ambiguous
30 Delayed or rescheduled?	This is the problem with using questions that rely on recall	Nothing that can be done	
31 Attitudes to screening	Need the question to be clearer. Would also be interesting and important to understand deterrent reasons for screening too.	Add options for women that have not previously had a mammogram in order to determine their reasons why etc. Add definition of uncomfortable – physically.	Justified by this woman's suggestion: "This is for people that have had mammogram. This is about people's perception. People who haven't had it may also perceive things like it being painful" (D) "To make it easier ...you might ask them to fill it in on the basis of what they think it will be" (D)
32 Risk of breast cancer in five years	Some women think differently in terms of numbers. A lot of women	Change to include the recurrence information for women with previously diagnosed breast cancer	Multiple women made suggestions such as:

Question Number	Problem identified	Action to be taken	Justification
	are hesitant to put down their estimate.		<p>“So that’s a scale of where you think your risk lies. Would that be equivalent to a percentage between zero and ten” (J)</p> <p>“Should include recurrence for women being diagnosed ‘In the next five years, how likely do you think it is that you will be diagnosed with breast cancer or a breast cancer recurrence?’” (K)</p>
33 Risk of breast cancer in lifetime	A lot of women are hesitant to put down their estimate.	Change to include the recurrence information for women with previously diagnosed breast cancer	
34 Date of birth	Anonymity issue	Change to include year of birth and first four digits of postcode rather than entire postcode	Cannot ensure anonymity with entire postcode and date of birth in smaller groups such as ethnic minorities
35 Postcode			
36 Ethnicity	No reported issues	Remove ‘other’ for ethnicity groups to improve anonymity of questionnaire	
37 Marital status	Preference of answer options for divorced women	Add additional option: “In a relationship, not cohabiting”	Adds additional detail and is less obstructive for women who meet this criteria
38 How occupy accommodation	Question format simplicity	Reword it to: “How would you describe your living arrangements?” and then give the current options	Re-wording the question makes it simpler. Will need to define household for question 42.
39 Education	No reported issues		
40 Employment	Answer options of question 40 and 41 to be combined in order to encompass it all	How would you describe your current employment role (over the last seven days) (please tick all that apply) - Full time work	“oh I didn’t notice it [RESEARCHER: maybe because of where the skip instruction is on that page?] yes maybe” (L) – Having it all
41 Employment			

Question Number	Problem identified	Action to be taken	Justification
		<ul style="list-style-type: none"> - Part time work - Self employed - In education full time - In education part time - Permanently unable to work due to long-term sickness or disability - Retired completely - Working intermittently - Looking after home and/or family - Never been employed - Other (please specify) 	in one question means no skip instruction is needed.
42 Income	Different women had different opinions	Define household term.	As only one woman disliked having to enter her salary (additionally, one rightly ticked the 'prefer not to say' box) no changes will be made
43 Illnesses	Bias of responses	Combine question 43 and 44: Do you suffer from any of these conditions? <ul style="list-style-type: none"> - Specify partial sight not correctable by reading glasses Then ask a follow-up question about how they affect you – home life, work life, daily activities, social life and love life.	People were answering either yes or no and finding the list not to be satisfactory for their ailment or realising that they should have ticked yes and then believing that they'd answered the questionnaire wrong. The suggested follow-up question would eliminate any confusion.
44 Health conditions			

Some additional questions were entered into the final draft to aid understanding of the woman's interpretation of some terms, for instance menopause. Further questions were added to obtain qualitative information about the negative consequences of BCS as this will help identify a woman's perspective of mammography in these terms. The majority of the interviewees selected no negative consequences but then went on to describe the negative consequences I was interested about in the interview. It is interesting to explore this further as it comprises a key part of IC. The scoring system for Likert scales for the experiences about mammography have been inverted for some questions in order to help reduce response bias and to reveal any basic underlying pattern of response unrelated to the actual questions/answers through inconsistencies (432).

The results of the interviews suggest that the majority of items (n=41/44) were acceptable and raised no issues about sensitivity. Two questions (about income and marital status) caused concern for one participant each. However, this appeared to be due to personal preference as the remaining twelve interviewees did not raise any issues with these questions. Furthermore, the income question has the option to 'prefer not to say' if women do not want to answer and the marital status question has been re-worded to include dating and non-cohabiting to be more inclusive to potential respondents.

The other question that caused a little concern was about weight. Many respondents commented in a comical manner *"I'm thinking do I give an honest answer"* (G) and highlighted that many women may estimate *"I'll estimate about 11 and a half stone"* (C) or underestimate *"... will always underestimate what they weigh or round down..."* (D).

Linguistically, a few questions were challenging for some of the participants, so some questions have been modified. Specifically, the interpretation of 'menopause' for the purpose of this questionnaire has been defined and additional questions have been added, for example it now asks if a monthly bleed was hormone induced. There is an additional question asking if the woman believes herself to be peri-menopausal (alongside a definition) which was previously not included in the questionnaire.

Every woman struggled with at least one of the definitions of previous diagnoses of breast conditions. Originally, I had assumed that if a woman had been diagnosed with one of the breast conditions they would know and remember what it was called. However, after analysing the transcripts, and almost all women agreeing that *"I don't know what they are"* (D), the question was adapted to include definitions alongside each option. This was similarly edited for the question asking about BRCA testing. I also removed the 'no' tick box after one participant highlighted *"it made me re-read this question, that's all. For me if none applied I wouldn't be expecting to tick a 'no' box"* (C).

Question eighteen and nineteen asked about 'screening'. Women's interpretation of what 'screening' meant ranged from *"screening programme in general"* (G) to *"just the mammogram"* (F) and *"that's the same thing isn't it, no? The screening programme is the mammogram as far as I'm aware"* (L). It was therefore deemed appropriate to highlight that those questions were asking about the population screening programme not just the mammogram.

Asking about the negative consequences of breast screening gave some interesting responses. Most women ticked no, but qualitatively went on to describe the negative consequences of breast screening that the question was asking about. When probed about this reaction most women were of the opinion *"there may be negative consequences in that people get anxious about it. But I don't so I'm trying to think from my perspective"* (B). So even though these women were aware of some negative consequences they were ticking that there were none. This could have been because of the question wording as it asks "Do you think..." and if women emphasised the 'you' this may be how they interpreted it differently from me. Therefore, additional probing exploratory questions have been inserted afterwards in the final questionnaire. Depending on a woman's answer they will probe what they think the negative consequences are or why they think there are no negative consequences. This will help capture women's true thoughts about this issue rather than a simple yes or no question.

There was an easily correctable error in the attitudes question identified by multiple women in that the last scale asking if women were willing to attend or if it was

something they felt they had to do was not comparable *"...I'm not sure they're two opposites"* (A). Additionally, one woman found the scale 'easy to difficult' confusing *"it's easy to attend. But actually having it done is not without drawbacks. Which sort of thing are you trying to...?"* (E). This question has now been changed to specify that the question is asking about accessibility of the screening service. Similarly, the scale about 'comfortable' has been changed to specify that it is asking about the physical comfort during the mammogram.

There were twelve items where women identified minor issues with response difficulties. Most were easily changed as described in *Table 24*. The biggest changes were changing question thirty-one from a five-point Likert scale to a strongly agree to strongly disagree scale because some identified that it was difficult putting a '1' as shy as it appeared negative whereas it was not a negative emotion *"on question 31 I'm incredibly shy when it comes to it but I'm circling a 1 as if it's not important whereas it's incredibly important [I'd prefer an agree to disagree scale]"* (H). The issue foreseen with this change is the worry that most women put 'neither agree nor disagree' but this is the same as entering a '3'. This question was also edited to make it clearer that I am asking about the experience (or anticipated experience) during the actual mammogram rather than the invitation process.

One woman verbalised her difficulty with reading the numbers of question twenty-three *"I find these numbers quite difficult to read [laughs]"* (E) and many commented *"I wouldn't know the numbers"* (D) or *"oh gosh I really don't know that [re-reads question] no I don't know that at all"* (L). One woman made an educated guess but admitted as a researcher *"I did a presentation yesterday to patients on BC and I looked at the stats so I'll go for B...but that's a guess"* (J). This highlighted a fundamental issue with the question that no woman knew the answer and most (n=12/13) were guessing. Therefore the question has been changed to explicitly state it is asking about overdiagnosis of BC and the answers have been changed to single digit options between zero and three which is more consistent with the BCS leaflet (63).

Whilst it did not apply for the participants of the interview, a difficulty was identified in questions forty and forty-one about employment status. These questions have

now been combined and changed into a 'tick all that apply' question to incorporate all options for people's circumstances of employment in order to not alienate anybody from the questionnaire. The consequences of this will be discussed in Section 6.9 below.

All recommendations as identified in the transcripts were given consideration. However, revision of an item was not based on the number of times the item was found to be problematic but the nature of the problem and whether it was deemed that it was personal preference or a general issue that would continue to be problematic to respondents. Simple changes include the addition of definitions of medical terms that are now provided as suggested by many women, particularly about the diagnoses and BRCA tests. The numbers of questions have been changed to a larger font to aid in transition with skip instructions *"It's just trying to find the right bit to go to..."* (C). A few women (n=9/13) had difficulty with the interpretation of what counted as a condition or illness during questions forty-three and forty-four. However, the intention of the question was not to only select certain conditions, and in fact the examples were meant as examples. Therefore, these questions have been combined and incorporated into a simpler "Do you suffer from...?" and then "in what way do they affect you...?"

Table 23 shows the final questionnaire in an abbreviated format. The full draft questionnaire is attached as Appendix 8.4.2 and the final draft questionnaire is attached as Appendix 8.4.4.

5.7 Discussion

In this chapter I have described how I developed a questionnaire to answer if personal demographics, risk of BC or IC are associated with uptake of BCS.

5.7.2 Questionnaire

Questionnaire is as a tool to obtain information are considered one of the most abused methods in research (407). Many believe it is simple to write a list of questions and get answers returned with respondent's opinions of a service. However, to truly gain meaning from a questionnaire study the crucial part is within the development phase, which is often overlooked.

A questionnaire such as this is investigating multi-dimensions associated with uptake of mammography (433). It is advised to make a questionnaire as short as possible to ensure maximum response rates. A trade-off exists between breadth and a questionnaires comprehensiveness and depth relating to precision of measuring each concept (434). This questionnaire remains lengthy due to the number of factors that are needed. Each item has been justified for inclusion as elaborated below.

However, questionnaires are limited. Many potential respondents feel unmotivated to complete the questionnaire, especially longer ones. Questions may appear irrelevant to some women or may be difficult to interpret.

The major methodological limitation of a questionnaire is that women may be answering a question differently to how the researcher intended. Whilst I have aimed to prevent and minimise this, by conducting cognitive interviews, it must remain a limitation as there is no way to identify this for each individual respondent.

5.7.3 Questionnaire development

The questionnaire was developed following guidelines from previous research (407, 435). Items were selected and adaptations from scales and questions used in published literature were used where possible. A PPI representative formed the first step in determining the appropriateness and usefulness of the questionnaire. Subsequently cognitive interviews were used to identify any errors or misleading questions.

There was significant debate between the research team and the PPI representative about the wording of questions asking about knowledge in the questionnaire. The original items were more direct and may have come across as quite strict thus increasing the risk of 'Don't Know' answers from respondents. As the knowledge section comes on page eight of a lengthy questionnaire, the questions were re-worded to be friendlier and to reduce the likelihood that respondents might feel judged. This meant that, semantically, in the final questionnaire there is a certain amount of overlap between assessing knowledge and beliefs about BCS. However, in the introductory paragraph to the knowledge questions it does state that we are asking about a woman's knowledge and perception of screening. In addition there is

some debate as to whether knowledge and beliefs are interchangeable – you cannot believe what you do not know (436).

By using closed questions, the researcher is limiting the richness of potential data from the questionnaire. However, these specific components have been identified as key predictors of uptake and are of known importance. Closed ended questions are required here for most questions in order to obtain relevant data that can be entered into a risk prediction model.

5.7.4 Cognitive interviews

The use of cognitive interviews has been discussed and criticised for a long time in association with the false environment set-up and the cognitive load on the respondent whilst completing the questionnaire (427). Whilst being cognitively interviewed, respondents are likely to take more care over their answers than they would in reality as described by the ‘Hawthorne effect’ (240). Whilst it is irrelevant which answer they select, as the desired outcome of the interview is to re-draft and reformat the questionnaire, respondents may feel compelled to answer in a socially desirable manner and as such may give untruthful descriptions about their interpretation of questions (427). Participants may not feel comfortable being honest about the limitations of the questionnaire or about sensitive or threatening questions as they are not as anonymous as the final questionnaire would be and they are talking directly with researcher (427). Previous literature has also criticised the technique as it is non-standardised, situationally artificial (the questionnaire respondent would not be interviewed about their answers by the researcher) and the analysis can be subjective (240).

Nevertheless, cognitive interviewing has many advantages that appear to outweigh these concerns and it continues to be a useful way of identifying potential problems with the questionnaire to redraft the tool for more accurate use ahead of the piloting phase. Furthermore it enables a process of checking that all relevant questions are asked and that the answer selection is appropriate (437). Being able to cognitively test the questionnaire ‘in use’ in a sample population is invaluable. The combination of these qualitative results with the validity and reliability testing will ultimately create a more substantial, useful questionnaire tool.

5.7.5 Interview outcomes

Overall, the questionnaire was complimented on its clarity and layout *“the questionnaire is nicely laid out with good spacing. It’s nice and clear”* (K). However, a lot of the questions relied on recall of information that some women struggled with, *“sometimes it’s just about memory”* (C). The general information provided at the start of the questionnaire has been edited to be much shorter than the first draft *“[I didn’t read it as] I’ve assumed that’s included in the participant information sheet”* (B). The skipping instructions were complimented throughout *“it’s good to have it right next to the question”* (C) so have not been changed.

Drennan *et al.* found problems generally arise in five domains. These domains have clear similarities and differences to the five categories highlighted via the content analysis of my cognitive interviews (240).

Table 23. Domains of cognitive interview analysis compared with previous research findings.

Drennen <i>et al.</i> domain	My domain	Definition and discussion
Linguistic	Lexical	The researcher over-estimates the vocabulary or understanding of the participant. This was apparent where definitions of terms used were not given on the original questionnaire draft.
Inclusion and exclusion	Sensitivities	In an interview or questionnaire setting, a respondent may bias an answer to appear favourable to the researcher, a term called social desirability response bias. Moreover, they may not include all relevant information, depending how they interpret the question.
Computational (This category overlaps with	Cognition	This includes recall and temporal recollection issues on which my questionnaire relies upon a lot. For instance, a question asks how many years the woman

Drennen <i>et al.</i> domain	My domain	Definition and discussion
their temporal domain too)		was taking HRT – identifying whether it was one year or two may become difficult to complete accurately the longer ago it was started.
Dissimilar	Recommendation	This became apparent as a key theme as my data is solely about the development of the tool and I was very keen to hear suggestions and comments about how to improve it.
Logical	Structure	The misunderstanding of conjoining questions or instructions. My questionnaire used simple and short questions and instructions in order to increase likelihood of being understood (438) throughout.

It was interesting to investigate if it was the same women who had problems recalling both age at menstruation and age at menopause. Of the thirteen women, eleven struggled or hesitated before recalling the age at which they started their periods, often with comments like *“difficult just because it’s such a long time ago. I can’t be precise but I think it’s about that”* (C). Only two women had clear recollection of the age *“I have a very good memory of that”* (M) and *“Period information is easily recalled – my mum was crying...”* (K). Of the ten women that were in menopause, four struggled to recall how long ago their last period was. Of the interviewees only two struggled with neither question. All women answered the questions.

5.8 Final draft of questionnaire

The saliency of a questionnaire, and each item, has an important influence on response rates. Therefore, much has been altered in the final draft of the questionnaire to limit the negative reactions of potential participants. All action

points noted above in *Table 24* have been accounted for and minor typographical errors changed.

The questionnaire includes nineteen questions asking about medical factors including menopause, menarche and parity as well as previous breast history. Twenty questions ask about participant's knowledge, attitude and behaviour about breast cancer and mammography. In the last section, the questionnaire comprises ten questions about personal characteristics including demographics like year of birth, income and health status. The new draft of the questionnaire is found in Appendix 8.4.5.

The next steps for the questionnaire design would be to further evaluate the updated questions to ensure no loss of content or meaning has occurred during the re-design post-analysis.

As the questions used here have not been previously used for research in this field, the questionnaire has not been evaluated or tested for its reliability yet. That is part of the process of developing a useful questionnaire and will be undertaken on this tool in the future.

I did not plan in this PhD to fully test the questionnaire. Some exploration of face (a subjective verdict of whether an item makes sense and assesses what it is meant to assess) and content (how well a question measures what it is intending to measure) validity has been established using the cognitive interviews (439). To complete the testing of this questionnaire draft, future research should pilot it using a larger number of participants. Further evaluation will seek to establish evidence in support of construct validity of the new questionnaire (that is, to confirm that it provides a true reflection of the construct under study). Since there is no 'gold-standard' for the evaluation of this construct, criterion-validity is not possible.

Data from this pilot phase can then be used to test internal consistency of the correlation between questions. The pilot data can also be used to test if the cut-off scores are appropriate to be classed as having a 'positive attitude towards screening' or 'good knowledge'. Reliability of the questionnaire in repeated tests can also be tested using the pilot data.

5.9 Strengths and limitations

To the best of the researcher's knowledge no questionnaire-based survey has been conducted that investigated the effect of personal risk of BC and IC on uptake. Previous work has been conducted in the UK using the IBIS risk estimation model which has identified it is feasible to incorporate individual risk estimation into the NHSBSP (419) and further research is warranted.

The IBIS model is currently used in practice in the UK for genetic cancer risk assessment and counselling for hereditary BC (440).

A limitation of this work is that it is not solely based on information that came from a systematic review of the literature e.g. for informed decision making. This was due to time constraints and the nonlinear process of the doctoral research. Future research would underpin the questionnaire by ensuring that it is compliant with systematic review findings.

Whilst cognitive interviewing is a useful technique to identify any problems with the questionnaire prior to its use with the general population, it may identify problems that would not have arisen or may fail to recognise some that will still appear in the general population survey phase (237). However it is hoped that these interviews have removed or reduced the likelihood of major mistakes being present in the survey.

Interview transcription was conducted immediately after meetings and meant data was only collected until it appeared that data saturation had been met. Although this is a largely subjective event as new data could have arisen during any interview. By the end of the thirteenth interview there had been no new data added that changed the results or course of action for three consecutive interviews and minimal new information prior to that.

The ethical approval in place for this research stipulated that recruitment should be conducted using personal connections only. Recruiting only from personal connections meant that the sample were not from diverse areas of the population and demographics. There is a risk of selection bias here as the study group were mainly sourced from the university newsletter and are not representative of the

target population (441). In hindsight further and/or different ethical approval should have been sought to enable recruitment from a larger sample to reflect a wider variety of respondents and their opinions.

A key limitation of this work is the sample used for these cognitive interviews. As discussed above, the absence of ethnic minority women or women using a first language that is not English is a significant flaw of the cognitive interview tests that can hopefully be rectified in future research and testing phases. As well, previous research has suggested women who comply with research are more likely to conform to suggested health behaviours (442). The presence of this confounding variable cannot be overlooked nor prevented.

Furthermore, nine out of the thirteen participants were women who either regularly undertake or are exposed to research in their working environment. One participant has previously worked in a bowel cancer screening development team which immediately biased her interview as she understood all terms regarding screening. The women interviewed often appeared hyperaware of possible selection bias with phrases such as *“so as a scientist I kind of know what they mean but as a patient or lay person I don’t think I would”* (J). However, these women continued to contribute helpful recommendations and improvements.

Regardless of the participants’ professions the aim of the cognitive interview phase was to obtain a range of knowledge and experiences. These women are all invited to participate in the NHSBSP every three years and therefore will be a component of the final population the questionnaire will be sent to. Therefore it is not a significant hindrance that these women were those who were cognitively interviewed.

Whilst some may argue that the researcher may introduce subjectivity and bias when analysing and presenting qualitative data, I would suggest that being involved and responsible at every step of the research process has allowed an in-depth knowledge of each interview, and attendant comments, participant feelings and results.

The employment status question was designed in order to obtain SES information about the respondent. However, by changing the question format the answers are

not compatible with census information. This may prove challenging with future comparative research and should be thoroughly investigated.

Previous research criticises the use of lengthy questionnaires wherever possible. Response rates declined from 70.2% for a two-page questionnaire to 57.1% for a four page questionnaire as measured using a questionnaire conducted in Norway (400). This is a limitation of administering the questionnaire in paper format. If the questionnaire were to be administered online then simple linking techniques could dramatically reduce the length for most women. Regardless, despite the questionnaire appearing lengthy it only takes between fifteen and thirty minutes to complete, depending on how much a woman has a family history of cancer.

Conclusions

Furthermore, in combination with the previous quantitative work packages and research findings, results from this future questionnaire have the potential to change the NHSBSP invitation process.

This questionnaire could be used to identify whether women are making ICs to attend/not attend BCS. It has the potential to be used to identify in which women knowledge is lacking or why certain women are not attending. Furthermore it can establish if women of high risk of developing BC are attending BCS or not. Importantly the questions asked in this questionnaire can be used to estimate a women's likelihood of developing BC and compare this to her current screening attendance values and behaviours. Whilst research of this type is in its infancy it will be an incredibly important tool in future to establish where tailored risk information or a decision aid can be utilised to encourage uptake in those at higher risk and to encourage an IC for all with personalised risk information for all women.

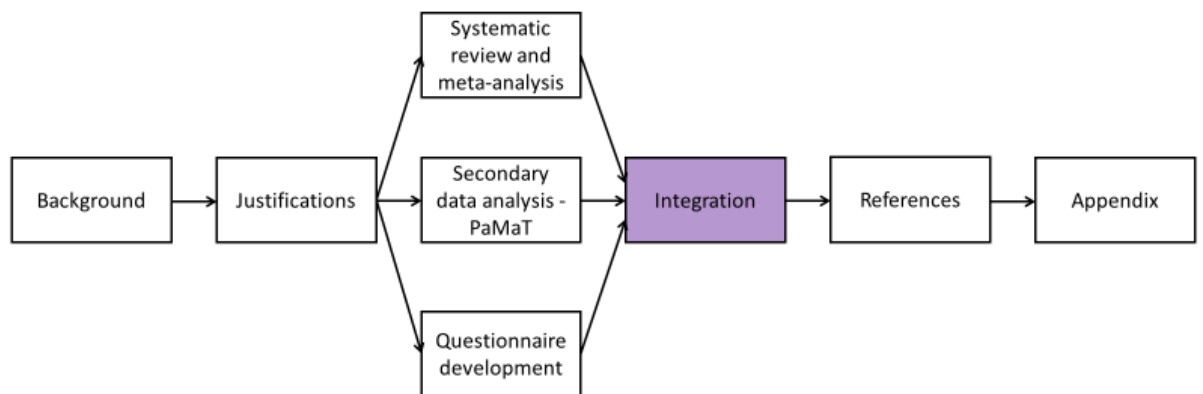
In research, a well-developed version of this questionnaire can be used to explore if a new leaflet allows a sufficient understanding and an IC to be made by women in mammography screening programme.

In clinical settings, the results of this questionnaire can be used to identify how best these groups could be targeted with tailored invitations and informative materials

where appropriate. Some women could also be given longer appointments to ask more detailed questions about areas of concern or to achieve an IC where necessary.

This questionnaire is in its early stages of development. Regardless of the purpose of the questionnaire, a concern about the length of the questionnaire remains and non-response may be high. Further testing and evaluation will seek to reduce the number of items with the hope to obtain high levels of acceptability in the target population.

Regardless, it is likely that those women who do not participate in the questionnaire are those who also do not attend BCS appointments. Uptake of the questionnaire could be improved with incentives, either financial or not, or it could be improved using public awareness campaigns relating to the questionnaire and its aim is to provide the ability to make an IC rather than uptake of BSP per se. Ideally, with further development the questionnaire can really focus on a relevant, unmet need of the target population which will encourage high completion rates.



Chapter 6: Integration, interpretation and conclusion

Introduction

The aim of this thesis has been to identify predictors of mammography attendance both worldwide and in the UK, as well as to develop a questionnaire for future investigation into predictors of BCS uptake.

Chapter two provided an overview of the literature. It provided a summary of predictors thought to influence uptake of mammography and showed some patterns in attendance explaining the need for the secondary data analysis. The chapter also clarified why IC was so important in modern screening policies.

Chapter three justified the research questions for the thesis and the overall rationale, research gap and thesis aims and objectives. Discussion about the contribution to the research field was offered. Methodologies that were to be used in the thesis were detailed and an overview of the studies provided.

Chapter four presented the results of a large systematic review of worldwide predictors of uptake. Meta-analysis was conducted on the data where quantitative data were available, narrative summary was undertaken where not. Data for thirty-one predictors of uptake were extracted from ninety-one papers.

Chapter five presented the results of the secondary analysis using data from a South West London screening centre. Multilevel modelling was conducted to assess predictors of uptake of mammography.

Chapter six explored the processes involved in the development of a tool to assess whether demographics, personal risk of BC and/or IC were predictors of uptake. I discussed the methods involved with PPI and cognitive interviews, results and outcomes including a final draft which can be found in Appendix 8.4.5. Further evaluation and testing of the tool is necessary before use.

6.1 Summary of studies

6.1.1 Systematic Review

As discussed in Chapter 4, the purpose of the systematic review was to determine the predictors of breast screening uptake worldwide. Ninety-one studies were included in the systematic review with data analysed quantitatively and narratively. The most important findings were that marital status, smoking status, having chronic conditions, the number of primary care visits and insurance status were found to be statistically significant predictors of uptake. There were non-statistically significant differences found in the proportions attending mammography by ethnicity, BMI, age, SES, income, housing tenure and education.

Furthermore, additional predictors were analysed narratively. Unanticipated findings from narratively analysed studies included higher rates of reported attendance in women who lived in rural areas, those who were victims of abuse or were caregivers. These studies may suffer from publication bias and/or other types of error such as a subjective analysis by the researcher. Attempt was made to minimise the likelihood of this bias by extracting any available data consistently for all articles included in the review (not just those analysed using meta-analysis) and all data extracted for the review was analysed rather than choosing which data to present.

As predicted from previous literature, the re-screening analysis showed that women who had previously attended were more likely to re-attend BCS. Controversially, having a previous false positive result was not significantly associated with uptake. A possible explanation for this might be that women react differently to the false positive result and the absence of a clear understanding of subsequent attendance patterns is a reflection of this.

6.1.2 Routine SW London dataset

The secondary data analysis aimed to investigate the predictors of mammography uptake in more detail using a South West London, UK dataset. This study found influential factors including older age and being of a minority ethnicity were

negatively associated with uptake but affluence, requiring a special appointment and having a previous recall were positively associated with general uptake of BCS.

As far as first episode attendance is concerned, it was interesting to find that only women within IMD deciles six and above were significantly more likely to attend their first episode compared with the most deprived women. Again, minority ethnic women were significantly less likely to attend and younger women were most likely to attend their first episode. Women requiring a special appointment were less likely to attend compared to women who did not.

The study detected some evidence for attendance at BCS having changed over time as year was found to be a significant predictor of attendance. Mammography attendance patterns have reversed for women requiring a special appointment and women with a previous recall, uptake has reduced for all ethnicities except White women, and declined for all SES groups and most age groups.

6.1.3 Questionnaire

This study set out to develop a questionnaire. Key aims were to evaluate if the questionnaire was appropriate for women aged between 47 and 73, to assess if there were any key questions raised by potential participants and to highlight any potential mistakes in the early development phase of the tool.

The use of a PPI representative and cognitive interviews with women who were of screening age were used to improve the questionnaire. Changes were implemented to key questions on topics including menopause, negative consequences of breast screening, current health status, employment status and attitudes about screening. These were important to ensure the questions were measuring the information researchers thought and wanted to obtain.

There is no doubt that a qualitative approach to exploring what women understand by informed choice would have been useful. However, the purpose of this questionnaire was not to explore their views and opinions on IC but to design a

questionnaire that could be used to explore if they make IC and how this affects their uptake pattern of mammography.

6.2 Integration of study findings

The purpose of the thesis was to investigate predictors of uptake and determine what, if any, were associated with attendance. The main goal of the review was to systematically analyse global data and the data analysis aimed to conduct analyses of local London uptake data. They are profoundly different populations and multiple different screening programmes were included in the systematic review.

Nevertheless, it was somewhat surprising that the systematic review and the secondary data analysis did not produce coherent results as shown in Table 25. A possible explanation for the inconsistencies may be because the underlying populations as well as the organisations of health services are fundamentally different.

The secondary data analysis did not have identical variables associated with uptake and was therefore always likely to find differences. However, a cause of concern remains with the discrepancy of results between those variables that were considered in both studies – for instance age, ethnicity and IMD/SES. The samples are so varied that generalisations would be hard to make anyway. However, the discrepancies impact the certainty of any recommendations or conclusions drawn from the results of either study as neither can be supported by the other.

When considering items from the questionnaire, questions were not simply based on the results of the previous two studies but also on questions used previously in other, similar questionnaires and questions were included for items that were imperative for making an IC, as explained in the previous chapter. Ideally, questions about demographics would have been based from the results of the studies I conducted. However, one of the main reasons for designing the questionnaire was to determine if demographics were associated with uptake and therefore this was not too concerning. Further to this, previous literature has suggested these factors are associated (as described above) so the questionnaire may be able to provide further confirmative or contrary evidence.

Table 24. Summary of comparisons between review and routine SW London database. n.s. = non-significant result. *=significant result at the $p<0.001$

<u>Predictor</u>	<u>Systematic review results</u>	<u>Routine SW London dataset results</u>	<u>Are the results of the studies in agreement?</u>
Statistically significant findings	None were significant	Ethnicity* SES* Age* Previous recall*	N/A
Ethnicity	Increased for White women vs Other women (non-significant)	Increased for White women vs Other women	Yes
SES	Affluent women less likely to attend (non-significant)	Affluent women more likely to attend	No
Age	Women aged 70 or over are less likely to attend (non-significant)	Women aged 70 or over are less likely to attend	Yes – but the finding was non-significant in the systematic review
Previous recall	Re-attendance data: women with a previous recall are less likely to re-attend (non-significant)	Women with a previous recall are more likely to re-attend	No

Within the SW London, UK setting, ethnicity, age, SES, previous recall and requiring a special appointment were all associated with uptake of BCS. From the systematic review, analyses suggest marital status, smoking status, suffering from a chronic condition, being uninsured and the number of primary care visits are significantly associated with the uptake of BCS. These predictors were useful and were incorporated into the development of the questionnaire.

6.3 Thesis strengths and limitations

Research aims were achieved in that each of my studies were completed.

The size of the systematic review is a key strength as it includes data from ninety-one studies. It followed a published protocol which increases reliability of the results (206). Two reviewers were used at all stages of the review and all papers were quality appraised. A major strength of the research was that self-report uptake data were excluded.

No studies from the developing world were found. This is unfortunate as that would likely have changed the outcomes and/or provided a sub-section analysis of the uptake in programmes in those countries. Only papers written in English were included in the review and this could account for the lack of studies from a wider geographical spread of countries. On the other hand, screening programmes in less economically developed countries are rare and perhaps this is the reason why so little has been published from these settings. This systematic review only investigated organised screening programmes and therefore opportunistic data were removed.

Furthermore, a significant amount of heterogeneity was found in these analyses. The statistical heterogeneity may have been because the samples included in the studies were large and therefore estimates, although varied, were very precise. Whilst caution should be used when interpreting the results, the amount of heterogeneity in the meta-analysis should not necessarily be considered a cause for concern. (Heterogeneity existing as a result of different patterns of organisation of breast

screening programmes may be a more important problem as discussed in section 4.6.4).

As multiple predictors were investigated using some of the same data, a type one bias may have been introduced. An attempt was made to reduce this by using a Bonferroni correction (260, 261). The review was complicated as it investigated a wide variety of different predictors. Nevertheless, it contributes significant information to the research field in terms of its breadth and increased understanding of the variety of different factors associated with attendance.

A noteworthy strength of the secondary analysis was the size of the database used. There were 915,546 episodes of mammography spanning over seventeen years. A key reason for the choice of dataset was its recording of ethnicity data. Whilst this was not complete for the dataset it did provide a large proportion of information of a variable thought to be strongly associated with mammography uptake.

The database selection itself could be a source of bias of the analysis and this should be considered. SW London was chosen due to its links with a supervisor previously associated with this research. Whilst there was no influence imposed by this relationship between the screening centre and the researcher, it does appear that a wider sample of screening centres could have been more appropriate, provided a wider representation of the UK population and allowed further analyses – for instance a comparison of results between a local centre and the SW London centre.

A key limitation remains that data were routinely collected for the screening programme and therefore do not contain the entire variable set that I would have preferred. If available it would have been important to include variables such as marital status, number of children, distance to screening site, car access, other health status (such as co-morbidities) or caring status. This would have allowed better comparison between the secondary and systematic review studies and would have provided a more complete evaluation of associations of uptake in SW London dataset.

Furthermore confounding variables cannot be accounted for, since other predictors may influence uptake and remain unidentified. Additionally ethnicity data were

missing for a proportion of the women. Whilst this was anticipated it still represents a limitation.

This type of analysis can only provide insight into associations between data rather than causation. Whilst we can speculate the cause of any association, the true relationship needs further investigation using different research methods. Another issue is that the composition of the database does not reflect the composition of the England and Wales population. The SW London population invited for and attending screening is over-representative of minority ethnic women and this might explain why poor uptake results were found when compared with nationally reported outcomes. The distribution of SES in the routine SW London database was skewed towards affluent women.

There were two key limitations noted for the questionnaire development study. Firstly, the sample used was only obtained via personal connections and as such was limited to a sub-group of the population – employment status (the large majority were researchers or worked in a research environment) and ethnicity (all were White British) and therefore are likely to have similar experiences to draw upon. However, sampling is a limitation of any such research and this limitation can be addressed in future development of the questionnaire in the pilot phase for instance. In hindsight, a different ethical approval would have allowed further cognitive interviews and exploration of women's views from different settings and would have removed the limitation of using only personal connections.

Secondly, the length of the questionnaire is an important limitation as previous research has highlighted (400, 443). Despite this, the questionnaire could not be made shorter, as layout and white space are important considerations of questionnaire design (383). I consider both aspects equally important but if one was to be chosen as more influential than the other then layout and white-space would need to be compromised in order for the content to remain.

Whilst the development of this questionnaire is important and is timely as the provision of healthcare is moving away from a paternalistic and towards a shared-decision making framework, more research is needed to address the gaps not

explored in this thesis. For instance, the introduction of IC in mammography screening is a new concept and as such it would be appropriate to explore the what is important for women to enable an IC, and to explore relevance and acceptability of this approach with members of the screening target audience. Furthermore, questionnaires consistently have low response rates. Research could discover what would encourage completion of this questionnaire if it had IC as the end-goal or perhaps identify what would make it more acceptable to the target audience prior to use in healthcare? Primarily, this questionnaire is only going to be useful to the screening programme if individuals are willing to use it.

6.4 Contribution to knowledge

Many predictors influence BCS attendance in a complicated matrix as shown in Figure 60. Indeed, the association between false positive results and likelihood of attendance was confusing and remains undeterminable.

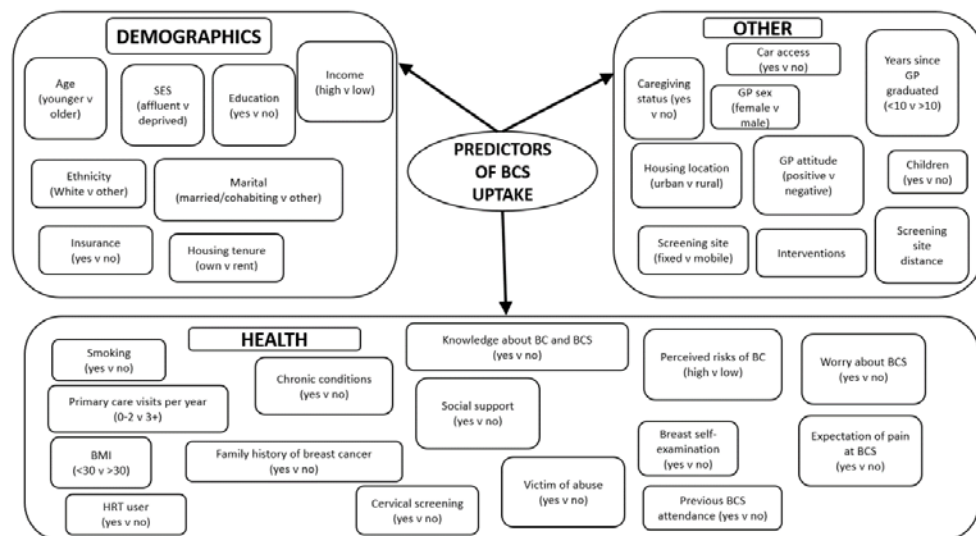


Figure 61. Predictors of BCS

At the time of conducting the research no review existed that examined all predictors of BCS attendance. As predictors of attendance are likely to influence mammography uptake in a complicated interlinked network, it is important to examine all potential factors in one place in order to start to try and understand their relationship to each other. This review was important to initiate this process and simultaneously update the understanding in research field.

Several studies have established that many variables predict uptake of mammography. This large study using recent routinely collected data in the UK updates previous similar studies (140) and has found that age, ethnicity, requiring a special appointment and having a previous recall episode are all significantly associated with the uptake of mammography.

Whilst components of the questionnaire which I designed have been used before in different health settings or conditions, the questions have not been used in breast screening in the UK (164, 236). This questionnaire and tool to measure IC is an innovative project and a tool such as this has not been previously created for breast screening. Future research should investigate the acceptability of the questionnaire itself which could help drive completion rates.

As a result of this PhD, research on predictors of mammography attendance has been updated both worldwide in my systematic review and in SW London using my secondary data analysis. Furthermore the development of a questionnaire to assess influence of personal BC risk, demographics and IC on uptake is underway. My PhD will directly support future research to identify whether women are making an IC and the impact of IC on attendance patterns, allowing us to understand this phenomenon better.

Regardless of its use in a future screening programme, the questionnaire could be used also for use in academia. As discussed above, the NHSBSP spent much money and time developing and updating the new mammography leaflet only to face significant criticism (as displayed in the introduction of the Appendix 8). This questionnaire, or questionnaire written from it, could be used to help identify if a future leaflet update meets certain criteria – does it provide enough information for a women to obtain sufficient knowledge to make an IC, does it provide enough information for women to have an attitude to BCS, and does it provide enough information for individuals to make IC about their decision to attend or not? This would be really important so any future leaflet updates meet ethical criteria (164).

6.5 Future research

Taken together the analyses show that more research is required to evaluate predictors associated with uptake of mammography in disparate screening programmes across the world. It would be useful to be able to understand predictors in relation to the organisation of screening programmes e.g. it was decided not to include opportunistic programmes in my systematic review as they are fundamentally different from organised screening programmes. No developing countries were included in this review and therefore future research should investigate uptake in these areas.

Considerably more work will need to be done to determine the effect of false positive results on subsequent re-attendance. As this predictor relied upon re-screening data it was not included in the main body of the review and is found instead in Appendix 8.2. However, the precise mechanism of action is yet to be confirmed and this would be a fruitful area and important for future work and would likely involve a review of the literature before in-depth qualitative interview methods to establish likely causes before wider interpretation and generalisability.

Previous work has found age, SES, education and housing tenure to be associated with uptake (75, 124, 127, 148), however this review found no statistically significant association. Further research should be undertaken to explore the effect of these predictors on uptake in each particular sub-group of women.

Following my PhD a repeat investigation of the secondary data analysis of the routine SW London dataset should be performed. Ideally, data from all screening centres should be obtained to ensure results are generalisable to the entire population rather than a subset. It is important to ensure the models fit to different, naïve datasets and so further work needs to be done to establish whether the models work.

Further work also needs to be carried out in the development of the questionnaire in order to validate and test the reliability of the tool. Subsequent to this the questionnaire needs to be used in research to inform practice so that we can fully understand the close links and implications of attitudes, personal BC risk, demographics and IC on uptake.

In addition, further studies need to be conducted regarding the best type of decision aid for potential participants of screening. This decision aid could be personalised based on risk or preference in order to ensure that an IC has been made regarding mammography attendance. However, the development of a useful decision aid cannot be started until the information is gathered and understood about how predictors influence attendance.

6.6 Key messages

For women, the key message that must be made is that many factors are influencing uptake and particular attention could be given to highlight the effects of each predictor.

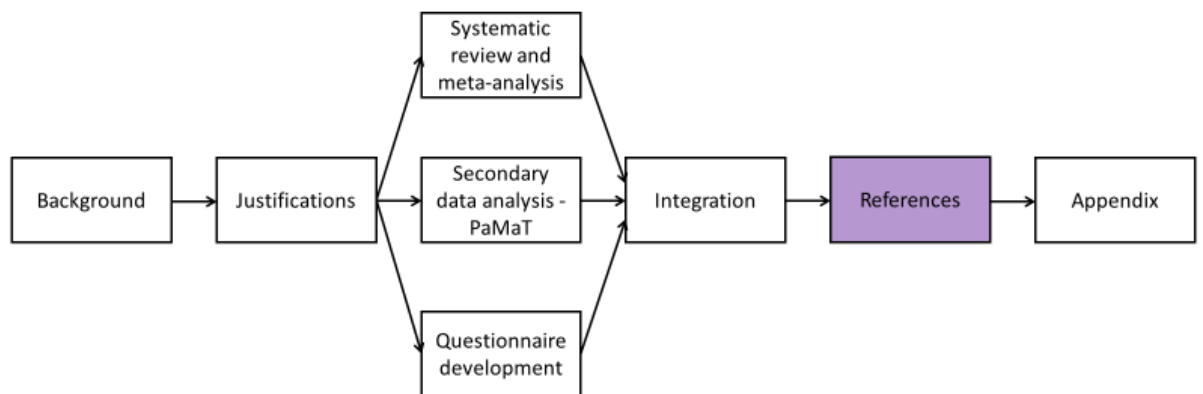
Health practitioners should be advised that the decision to attend mammography is personal and that multiple predictors influence this decision. Health practitioners should be given the results of this research to explore which women are potentially being missed (for instance minority ethnic groups in SW London) to allow for the provision of policies to encourage more equitable access.

Ethically IC is one of the most important considerations for running a screening programme and therefore policy should account for this (62, 102). New guidelines should be written to represent these new feelings towards the decision following practice in Germany (190). In conjunction with further academic research investigating decision aids and personalised information, the NHSBSP leaflet should be redesigned to incorporate the findings.

Chapter summary

This chapter has reviewed the research problems addressed in each chapter and provided a summary of each study before integrating its findings. The chapter has reported the main strengths and limitations found within each study and highlighted the contribution this thesis has made to the research field. Future research recommendations have been provided based on limitations of the current studies or

research problems that either have yet to be resolved or have arisen from conducting this body of work. This chapter ends with key messages aimed at women, health practitioners, the NHSBSP policymakers and academia.



Chapter 7: References

1. Torre LA, Bray F, Siegel RL, Ferlay J, Lortet-Tieulent J, Jemal A. Global cancer statistics, 2012. *CA: A Cancer Journal for Clinicians*. 2015;65(2):87-108.
2. McPherson K, Steel CM, Dixon JM. Breast cancer—epidemiology, risk factors, and genetics. *BMJ*. 2000;321(7261):624-8.
3. CancerResearch;. Breast cancer incidence (invasive) statistics [Website]. CRUK; 2017 [cited 2017 July]. Available from: <http://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/breast-cancer/incidence-invasive#heading-Two>.
4. ONS;. Breast Cancer: Incidence, Mortality and Survival, 2010. PDF. Office for National Statistics; 2012 28 September 2012.
5. ONS;. Cancer Incidence in England 1990 to 2015: Final. Data. London: ONS; 2017 03.07.17. Contract No.: 007188.
6. Screening and Immunisations Team HSCIC. Breast Screening Programme, England. Statistics for 2014-15. PDF. Health and Social Care Information Centre; 2016 February 2016.
7. Giordano L, Giorgi D, Ventura L, Castagno R, Paci E, Segnan N. Time trends of process and impact indicators in Italian breast screening programmes (1999-2009). *Epidemiol Prev*. 2011;35(5-6 Suppl 5):28-38.
8. Duffy SW, Agbaje O, Tabar L, Vitak B, Bjurstam N, Bjorneld L, et al. Overdiagnosis and overtreatment of breast cancer: estimates of overdiagnosis from two trials of mammographic screening for breast cancer. *Breast Cancer Res*. 2005;7(6):258-65.
9. Paci E, Warwick J, Falini P, Duffy SW. Overdiagnosis in Screening: Is the Increase in Breast Cancer Incidence Rates a Cause for Concern ? *Journal of Medical Screening*. 2004;11(1):23-7.
10. Tyrer J, Duffy SW, Cuzick J. A breast cancer prediction model incorporating familial and personal risk factors. *Statistics in medicine*. 2004;23(7):1111-30.
11. Amir E, Freedman OC, Seruga B, Evans DG. Assessing Women at High Risk of Breast Cancer: A Review of Risk Assessment Models. *JNCI: Journal of the National Cancer Institute*. 2010;102(10):680-91.
12. Gail MH. Personalized estimates of breast cancer risk in clinical practice and public health. *Statistics in medicine*. 2011;30(10):1090-104.
13. Key TJ, Verkasalo PK, Banks E. Epidemiology of breast cancer. *The Lancet Oncology*. 2001;2(3):133-40.
14. Washbrook E. Risk factors and epidemiology of breast cancer. *Women's Health Medicine*. 2006;3(1):8-14.
15. Ferlay JS, I; Ervik, M; Dikshit, R; Eser, S; Mathers, C; Rebelo, M; Parkin, DM; Forman, D; Bray, F;. Cancer Incidence and Mortality Worldwide: IARC CancerBase No.11 [Internet] International Agency for Research on Cancer: World Health Organisation; 2012 [cited 2017 July]. Available from: http://globocan.iarc.fr/Pages/fact_sheets_cancer.aspx?cancer=breast.
16. DeSantis C, Ma J, Bryan L, Jemal A. Breast cancer statistics, 2013. *CA: A Cancer Journal for Clinicians*. 2014;64(1):52-62.
17. DeSantis CE, Fedewa SA, Goding Sauer A, Kramer JL, Smith RA, Jemal A. Breast cancer statistics, 2015: Convergence of incidence rates between black and white women. *CA: A Cancer Journal for Clinicians*. 2016;66(1):31-42.

18. Chlebowski RT, Chen Z, Anderson GL, Rohan T, Aragaki A, Lane D, et al. Ethnicity and Breast Cancer: Factors Influencing Differences in Incidence and Outcome. *JNCI: Journal of the National Cancer Institute*. 2005;97(6):439-48.
19. Sheinfeld Gorin S, Gauthier J, Hay J, Miles A, Wardle J. Cancer screening and aging: Research barriers and opportunities. *Cancer*. 2008;113(S12):3493-504.
20. Cappellani A, Vita MD, Zanghì A, Cavallaro A, Piccolo G, Majorana M, et al. Prognostic factors in elderly patients with breast cancer. *BMC Surgery*. 2013;13(2):S2.
21. Kelsey JL, Bernstein L. Epidemiology and Prevention of Breast Cancer. *Annual Review of Public Health*. 1996;17(1):47-67.
22. Collaborative Group on Hormonal Factors in Breast C. Menarche, menopause, and breast cancer risk: individual participant meta-analysis, including 118 964 women with breast cancer from 117 epidemiological studies. *The Lancet Oncology*. 2012;13(11):1141-51.
23. MacMahon B, Cole P, Lin TM, Lowe CR, Mirra AP, Ravnihar B, et al. Age at first birth and breast cancer risk. *Bulletin of the World Health Organization*. 1970;43(2):209-21.
24. Collaborative Group on Hormonal Factors in Breast Cancer. Familial breast cancer: collaborative reanalysis of individual data from 52 epidemiological studies including 58,209 women with breast cancer and 101,986 women without the disease. *The Lancet*. 2001;358(9291):1389-99.
25. Ma H, Ursin G, Xu X, Lee E, Togawa K, Duan L, et al. Reproductive factors and the risk of triple-negative breast cancer in white women and African-American women: a pooled analysis. *Breast Cancer Research*. 2017;19(1):6.
26. Collaborative Group on Hormonal Factors in Breast Cancer. Breast cancer and breastfeeding: collaborative reanalysis of individual data from 47 epidemiological studies in 30 countries, including 50,302 women with breast cancer and 96,973 women without the disease. *The Lancet*. 2002;360(9328):187-95.
27. Pharoah PDP, Day NE, Duffy S, Easton DF, Ponder BAJ. Family history and the risk of breast cancer: A systematic review and meta-analysis. *International Journal of Cancer*. 1997;71(5):800-9.
28. Tice JA, Cummings SR, Ziv E, Kerlikowske K. Mammographic Breast Density and the Gail Model for Breast Cancer Risk Prediction in a Screening Population. *Breast Cancer Research and Treatment*. 2005;94(2):115-22.
29. Boyd NF, Guo H, Martin LJ, Sun L, Stone J, Fishell E, et al. Mammographic Density and the Risk and Detection of Breast Cancer. *New England Journal of Medicine*. 2007;356(3):227-36.
30. Cancer; CGoHFIB. Breast cancer and hormonal contraceptives: collaborative reanalysis of individual data on 53 297 women with breast cancer and 100 239 women without breast cancer from 54 epidemiological studies. *The Lancet*. 1996;347(9017):1713-27.
31. Beral VMWSC. Breast cancer and hormone-replacement therapy in the Million Women Study. *The Lancet*. 2003;362(9382):419-27.
32. Colditz GA. Relationship Between Estrogen Levels, Use of Hormone Replacement Therapy, and Breast Cancer. *JNCI: Journal of the National Cancer Institute*. 1998;90(11):814-23.
33. Steinberg KK, Thacker SB, Smith S, et al. A meta-analysis of the effect of estrogen replacement therapy on the risk of breast cancer. *JAMA*. 1991;265(15):1985-90.
34. Harvie M, Hooper L, Howell AH. Central obesity and breast cancer risk: a systematic review. *Obesity reviews : an official journal of the International Association for the Study of Obesity*. 2003;4(3):157-73.

35. Sanderson M, Lipworth L, Shen-Miller D, Nechuta S, Beeghly-Fadiel A, Shrubsole MJ, et al. Energy-Related Indicators and Breast Cancer Risk among White and Black Women. *PLoS One*. 2015;10(4):e0125058.
36. Pronk A, Ji BT, Shu XO, Chow WH, Xue S, Yang G, et al. Physical activity and breast cancer risk in Chinese women. *British Journal of Cancer*. 2011;105(9):1443-50.
37. Bernstein L, Patel AV, Ursin G, Sullivan-Halley J, Press MF, Deapen D, et al. Lifetime Recreational Exercise Activity and Breast Cancer Risk Among Black Women and White Women. *JNCI: Journal of the National Cancer Institute*. 2005;97(22):1671-9.
38. Gong Z, Hong C-C, Bandera EV, Adams-Campbell LL, Troester MA, Park S-Y, et al. Vigorous physical activity and risk of breast cancer in the African American breast cancer epidemiology and risk consortium. *Breast Cancer Research and Treatment*. 2016;159(2):347-56.
39. Sheppard VB, Makambi K, Taylor T, Wallington SF, Sween J, Adams-Campbell L. Physical activity reduces breast cancer risk in African American women. *Ethn Dis*. 2011;21(4):406-11.
40. Seitz HK, Becker P. Alcohol Metabolism and Cancer Risk. *Alcohol Research & Health*. 2007;30(1):38-47.
41. International Agency for Research on Cancer. Re-evaluation of some organic chemicals, hydrazine and hydrogen peroxide. Proceedings of the IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. Lyon, France, 17-24 February 1998. IARC monographs on the evaluation of carcinogenic risks to humans. 1999;71 Pt 1:1-315.
42. Liu Y, Nguyen N, Colditz GA. Links between alcohol consumption and breast cancer: a look at the evidence. *Women's health (London, England)*. 2015;11(1):65-77.
43. Collaborative Group on Hormonal Factors in Breast Cancer. Alcohol, tobacco and breast cancer – collaborative reanalysis of individual data from 53 epidemiological studies, including 58 515 women with breast cancer and 95 067 women without the disease. *British Journal of Cancer*. 2002;87(11):1234-45.
44. Danaei G, Vander Hoorn S, Lopez AD, Murray CJL, Ezzati M. Causes of cancer in the world: comparative risk assessment of nine behavioural and environmental risk factors. *The Lancet*. 2005;366(9499):1784-93.
45. Catsburg C, Miller AB, Rohan TE. Active cigarette smoking and risk of breast cancer. *Int J Cancer*. 2015;136(9):2204-9.
46. Amir E, Evans DG, Shenton A, Lalloo F, Moran A, Boggis C, et al. Evaluation of breast cancer risk assessment packages in the family history evaluation and screening programme. *Journal of medical genetics*. 2003;40(11):807-14.
47. Evans D, Astley S, Stavrinou P. PROCAS: Predicting Risk of Breast Cancer at Screening. In: Improvement in risk prediction edapobcitNBSPafhcadcs, editor. Southampton (UK): NIHR Journals Library; 2016.
48. French DP, Southworth J, Howell A, Harvie M, Stavrinou P, Watterson D, et al. Psychological impact of providing women with personalised 10-year breast cancer risk estimates. *Br J Cancer*. 2018;118(12):1648-57.
49. Destounis S, Arieno A, Morgan R, Roberts C, Chan A. Qualitative Versus Quantitative Mammographic Breast Density Assessment: Applications for the US and Abroad. *Diagnostics*. 2017;7(2):30.
50. Gail MH, Brinton LA, Byar DP, Corle DK, Green SB, Schairer C, et al. Projecting individualized probabilities of developing breast cancer for white females who are being examined annually. *J Natl Cancer Inst*. 1989;81(24):1879-86.
51. Geller BM, Yankaskas BC, Buist DSM, White E, Tice JA, Kerlikowske K, et al. Prospective Breast Cancer Risk Prediction Model for Women Undergoing Screening

- Mammography. JNCI: Journal of the National Cancer Institute. 2006;98(17):1204-14.
52. Wilson JMGJG. Principles and Practice of Screening for Disease. 1968;34:168.
53. Zavan MR. Principles and practice of screening for disease. Archives of Internal Medicine. 1969;123(3):349-.
54. Raffle AEG, Muir J.A.; Screening: evidence and practice. New York: Oxford University Press; 2007. 317 p.
55. Blanchard K, Colbert JA, Puri D, Weissman J, Moy B, Kopans DB, et al. Mammographic screening: patterns of use and estimated impact on breast carcinoma survival. Cancer. 2004;101(3):495-507.
56. Blanks RG, Moss SM, McGahan CE, Quinn MJ, Babb PJ. Effect of NHS breast screening programme on mortality from breast cancer in England and Wales, 1990-1998: comparison of observed with predicted mortality. BMJ. 2000;321.
57. Ferlay J, Parkin DM, Steliarova-Foucher E. Estimates of cancer incidence and mortality in Europe in 2008. Eur J Cancer. 2010;46.
58. Autier P, Boniol M. Mammography screening: A major issue in medicine. European Journal of Cancer. 2018;90:34-62.
59. Gotzsche PC. Mammography screening: truth, lies and controversy: Radcliffe Publishing Ltd; 2012.
60. Gotzsche PC, Hartling OJ, Nielsen M, Brodersen J, Jørgensen KJ. Breast screening: the facts—or maybe not. BMJ. 2009;338.
61. Gotzsche PC, Jørgensen KJ. The Breast Screening Programme and misinforming the public. Journal of the Royal Society of Medicine. 2011;104(9):361-9.
62. Berens E-M, Reder M, Kolip P, Spallek J. A cross-sectional study on informed choice in the mammography screening programme in Germany (InEMa): a study protocol. BMJ Open. 2014;4(9).
63. Cancer Research UK. Helping You Decide. In: UK CR, editor. Informed Choice about Cancer Screening. King's Health Partners: Informed Choice about Cancer Screening; 2013. p. 16.
64. Mushlin AI, Kouides RW, Shapiro DE. Estimating the accuracy of screening mammography: a meta-analysis. Am J Prev Med. 1998;14(2):143-53.
65. Moser K, Sellars S, Wheaton M, Cooke J, Duncan A, Maxwell A, et al. Extending the age range for breast screening in England: pilot study to assess the feasibility and acceptability of randomization. J Med Screen. 2011;18(2):96-102.
66. Screening and Immunisations Team HSCIC. Breast Screening Programme, England. Statistics for 2013-14. PDF. Health and Social Care Information Centre; 2015 February 2015.
67. Independent UK Panel on Breast Cancer Screening. The benefits and harms of breast cancer screening: an independent review. Lancet (London, England). 2012;380(9855):1778-86.
68. Alexander FE, Anderson TJ, Brown HK, Forrest APM, Hepburn W, Kirkpatrick AE, et al. 14 years of follow-up from the Edinburgh randomised trial of breast-cancer screening. The Lancet. 353(9168):1903-8.
69. Screening; ACoBC. Screening for Breast Cancer England: Past and Future. Sheffield: NHS Cancer Screening Programmes, Programmes NCS; 2006 2006. Contract No.: 61.
70. Moss SM, Cuckle H, Evans A, Johns L, Waller M, Bobrow L. Effect of mammographic screening from age 40 years on breast cancer mortality at 10 years' follow-up: a randomised controlled trial. Lancet (London, England). 2006;368(9552):2053-60.
71. Pace LE, Keating NL. A systematic assessment of benefits and risks to guide breast cancer screening decisions. Jama. 2014;311(13):1327-35.

72. Pearson M. Understanding Uncertainty 2015 [cited 2017 August 1st]. Available from: <http://understandinguncertainty.org/visualisation-information-nhs-breast-cancer-screening-leaflet>.
73. Foot CH, Tony. How to improve cancer survival. Explaining England's relatively poor rates. The Kings Fund;; The Kings Fund;; 2011 2011.
74. The Canadian Task Force on Preventive Health C. Recommendations on screening for breast cancer in average-risk women aged 40–74 years. CMAJ : Canadian Medical Association Journal. 2011;183(17):1991-2001.
75. Lagerlund M, Maxwell AE, Bastani R, Thurfjell E, Ekblom A, Lambe M. Sociodemographic predictors of non-attendance at invitational mammography screening - A population-based register study (Sweden). Cancer Causes and Control. 2002;13(1):73-82.
76. Gotzsche PC, Nielsen M. Screening for breast cancer with mammography. The Cochrane database of systematic reviews. 2011(1):Cd001877.
77. Calnan M. The health belief model and participation in programmes for the early detection of breast cancer: A comparative analysis. Social Science & Medicine. 1984;19(8):823-30.
78. Vernon SW, Laville EA, Jackson GL. Participation in breast screening programs: A review. Social Science & Medicine. 1990;30(10):1107-18.
79. Aarts MJ, Voogd AC, Duijm LEM, Coebergh JWW, Louwman WJ. Socioeconomic inequalities in attending the mass screening for breast cancer in the south of the Netherlands-associations with stage at diagnosis and survival. Breast Cancer Research and Treatment. 2011;128(2):517-25.
80. Marmot MG, Stansfeld S, Patel C, North F, Head J, White I, et al. Health inequalities among British civil servants: the Whitehall II study. The Lancet.337(8754):1387-93.
81. Lawrence GK, Olive; Lagord, Catherine; Cheung, Shan; Sidhu, Jasmin; Sagar, Colin. The Second All Breast Cancer Report, Focussing on Inequalities: variations in breast cancer outcomes by age and deprivation. National Cancer intelligence Network; 2011 2011.
82. Ward E, Jemal A, Cokkinides V, Singh GK, Cardinez C, Ghafoor A, et al. Cancer Disparities by Race/Ethnicity and Socioeconomic Status. CA: A Cancer Journal for Clinicians. 2004;54(2):78-93.
83. Hershman DM, Russell; Jacobson, Judith S.; Lamerato, Lois; Roberts, Kevin; Grann, Victor R.; Neugut, Alfred I.;. Racial disparities in treatment and survival among women with early-stage breast cancer. Journal of Clinical Oncology. 2005;22(27):6639-46.
84. Marmot M, Allen J, Goldblatt P, Boyce T, McNeish D, Grady M, et al. Fair society, Healthy Lives: Strategic Review of Health Inequalities in England post-2010. London: The Marmot Review; 2010.
85. Welch HG, Black WC. Overdiagnosis in Cancer. JNCI: Journal of the National Cancer Institute. 2010;102(9):605-13.
86. Hersch J, Jansen J, McCaffery K. Decision-making about mammographic screening: pursuing informed choice. Climacteric. 2018;21(3):209-13.
87. Duffy SW, Tabar L, Olsen AH, Vitak B, Allgood PC, Chen TH, et al. Absolute numbers of lives saved and overdiagnosis in breast cancer screening, from a randomized trial and from the Breast Screening Programme in England. J Med Screen. 2010;17(1):25-30.
88. National Institute for Health and Care Excellence. Early and locally advanced breast cancer overview United Kingdom: NICE; 2017 [updated November 2015; cited 2017 September, 28th]. Available from: <https://pathways.nice.org.uk/pathways/early-and-locally-advanced-breast-cancer#content=view-index>.

89. Forrest P. Breast Cancer Screening: report to the health ministers of England, Wales, Scotland & Northern Ireland. London: Department of Health and Social Science, Security DoHaS; 1986.
90. Moss S. Overdiagnosis and overtreatment of breast cancer: overdiagnosis in randomised controlled trials of breast cancer screening. *Breast Cancer Res.* 2005;7(5):230-4.
91. Smith RA, Duffy SW, Gabe R, Tabar L, Yen AM, Chen TH. The randomized trials of breast cancer screening: what have we learned? *Radiologic clinics of North America.* 2004;42(5):793-806, v.
92. Olsen AH, Agbaje OF, Myles JP, Lynge E, Duffy SW. Overdiagnosis, Sojourn Time, and Sensitivity in the Copenhagen Mammography Screening Program. *The Breast Journal.* 2006;12(4):338-42.
93. Yen MF, Tabar L, Vitak B, Smith RA, Chen HH, Duffy SW. Quantifying the potential problem of overdiagnosis of ductal carcinoma in situ in breast cancer screening. *Eur J Cancer.* 2003;39(12):1746-54.
94. Gotzsche PC, Nielsen M. Screening for breast cancer with mammography. The Cochrane database of systematic reviews. 2009(4):Cd001877.
95. Jørgensen KJ, Gøtzsche PC. Overdiagnosis in publicly organised mammography screening programmes: systematic review of incidence trends. *BMJ.* 2009;339.
96. Marmot MIUPoBCS. The benefits and harms of breast cancer screening: an independent review. *The Lancet.* 2012;380(9855):1778-86.
97. Zackrisson S, Andersson I, Janzon L, Manjer J, Garne JP. Rate of over-diagnosis of breast cancer 15 years after end of Malmö mammographic screening trial: follow-up study. *BMJ : British Medical Journal.* 2006;332(7543):689-92.
98. Whelehan P, Evans A, Wells M, Macgillivray S. The effect of mammography pain on repeat participation in breast cancer screening: a systematic review. *Breast.* 2013;22(4):389-94.
99. Brett J, Austoker J. Women who are recalled for further investigation for breast screening: psychological consequences 3 years after recall and factors affecting re-attendance. *J Public Health.* 2001;23(4):292-300.
100. Bond M, Pavey T, Welch K, Cooper C, Garside R, Dean S, et al. Systematic review of the psychological consequences of false-positive screening mammograms. *Health technology assessment (Winchester, England).* 2013;17(13):1-170, v-vi.
101. Nelson HD, Pappas M, Cantor A, Griffin J, Daeges M, Humphrey L. Harms of Breast Cancer Screening: Systematic Review to Update the 2009 U.S. Preventive Services Task Force Recommendation. *Annals of internal medicine.* 2016;164(4):256-67.
102. Raffle AE. Information about screening - is it to achieve high uptake or to ensure informed choice? *Health Expectations.* 2001;4(2):92-8.
103. Breast Cancer Deadline. Mammography for Breast Cancer Screening: Harm/Benefit Analysis. Washington: National Breast Cancer Coalition; 2011 July 2011.
104. Cooke R, Sniehotta F, Schüz B. Predicting binge-drinking behaviour using an extended TBP: examining the impact of anticipated regret and descriptive norms. *Alcohol and Alcoholism.* 2006;42(2):84-91.
105. Norman P, Conner M, Bell R. The Theory of Planned Behaviour and exercise: Evidence for the moderating role of past behaviour. *British Journal of Health Psychology.* 2000;5(3):249-61.
106. Norman P, Fitter M. Predicting attendance at health screening: organizational factors and patients' health beliefs. *Counselling Psychology Quarterly.* 1991;4.
107. Verplanken B, Aarts H, van Knippenberg A, Moonen A. Habit versus planned behaviour: A field experiment. *British Journal of Social Psychology.* 1998;37(1):111-28.

108. Ajzen I. The theory of planned behavior. *Organizational Behavior and Human Decision Processes*. 1991;50(2):179-211.
109. Wilson S, Sisk RJ, Baldwin KA. Health beliefs of blue collar workers: increasing self efficacy and removing barriers. *AAOHN J*. 1997;45.
110. Madden TJ, Ellen PS, Ajzen I. A Comparison of the Theory of Planned Behavior and the Theory of Reasoned Action. *Personality and Social Psychology Bulletin*. 1992;18(1):3-9.
111. Rosenstock IM, Strecher VJ, Becker MH. Social Learning Theory and the Health Belief Model. *Health Education Quarterly*. 1988;15(2):175-83.
112. Kim H-S, Ahn J, No J-K. Applying the Health Belief Model to college students' health behavior. *Nutrition Research and Practice*. 2012;6(6):551-8.
113. Munro S, Lewin S, Swart T, Volmink J. A review of health behaviour theories: how useful are these for developing interventions to promote long-term medication adherence for TB and HIV/AIDS? *BMC public health*. 2007;7:104-.
114. Coyle C, Kinnear H, Rosato M, Mairs A, Hall C, O'Reilly D. Do women who intermittently attend breast screening differ from those who attend every invitation and those who never attend? *Journal of Medical Screening*. 2012;19(2):98-103.
115. Ross NA, Rosenberg MW, Pross DC, Bass B. Contradictions in women's health care provision: A case study of attendance for breast cancer screening. *Social Science & Medicine*. 1994;39(8):1015-25.
116. Scaf-Klomp W, van Sonderen FL, Stewart R, van Dijck JA, van den Heuvel WJ. Compliance after 17 years of breast cancer screening. *Journal of medical screening*. 1995;2(4):195-9.
117. Lechner L, de Vries H, Offermans N. Participation in a breast cancer screening program: influence of past behavior and determinants on future screening participation. *Prev Med*. 1997;26(4):473-82.
118. Edwards NI, Jones DA. Uptake of breast cancer screening in older women. Age and ageing. 2000;29(2):131-5.
119. Meiser B, Butow P, Barratt A, Friedlander M, Kirk J, Gaff C, et al. Breast cancer screening uptake in women at increased risk of developing hereditary breast cancer. *Breast Cancer Research and Treatment*. 2000;59(2):101-11.
120. Barratt AL, Cockburn J, Redman S, Paul C, Perkins J. Mammographic screening: results from the 1996 National Breast Health Survey. *Med J Aust*. 1997;167(10):521-4.
121. Freitas C, Tura LF, Costa N, Duarte J. A population-based breast cancer screening programme: conducting a comprehensive survey to explore adherence determinants. *Eur J Cancer Care (Engl)*. 2012;21(3):349-59.
122. Dryden R, Williams B, McCowan C, Themessl-Huber M. What do we know about who does and does not attend general health checks? Findings from a narrative scoping review. *BMC Public Health*. 2012;12(1):723.
123. Haddad FG, Kourie HR, Adib SM. Trends in mammography utilization for breast cancer screening in a Middle-Eastern country: Lebanon 2005-2013. *Cancer Epidemiol*. 2015;39(6):819-24.
124. Damiani G, Federico B, Basso D, Ronconi A, Bianchi CB, Anzellotti GM, et al. Socioeconomic disparities in the uptake of breast and cervical cancer screening in Italy: a cross sectional study. *BMC Public Health*. 2012;12:99.
125. Aro AR, Koning HJ, Absetz P, Schreck M. Psychosocial predictors of first attendance for organised mammography screening. *Journal of medical screening [Internet]*. 1999; 6(2):[82-8 pp.]. Available from:

<http://onlinelibrary.wiley.com/o/cochrane/clcentral/articles/380/CN-00166380/frame.html>.

126. Caleffi M, Ribeiro RA, Bedin AJ, Jr., Viegas-Butzke JM, Baldisserotto FD, Skonieski GP, et al. Adherence to a breast cancer screening program and its predictors in underserved women in southern Brazil. *Cancer Epidemiol Biomarkers Prev*. 2010;19(10):2673-9.
127. Damiani G, Basso D, Acampora A, Bianchi CB, Silvestrini G, Frisicale EM, et al. The impact of level of education on adherence to breast and cervical cancer screening: Evidence from a systematic review and meta-analysis. *Prev Med*. 2015;81:281-9.
128. Lagerlund M, Sparén P, Thurfjell E, Ekborn A, Lambe M. Predictors of non-attendance in a population-based mammography screening programme; socio-demographic factors and aspects of behaviour. *Eur J Can Prev*. 2000;9.
129. Achat H, Close G, Taylor R. Who has regular mammograms? Effects of knowledge, beliefs, socioeconomic status, and health-related factors. *Prev Med*. 2005;41(1):312-20.
130. Taylor R, Ivanov O, Page A, Brotherton J, Achat H, Close G. Predictors of non-attendance from BreastScreen NSW in women who report current mammography screening. *Australian and New Zealand journal of public health*. 2003;27(6):581-7.
131. Zackrisson S, Andersson I, Manjer J, Janzon L. Non-attendance in breast cancer screening is associated with unfavourable socio-economic circumstances and advanced carcinoma. *International Journal of Cancer*. 2004;108(5):754-60.
132. Relecom A, Arzel B, Perneger T. Effect of an organised screening program on socioeconomic inequalities in mammography practice, knowledge and attitudes. *Intern*. 2018;17(1):95.
133. Banks E, Beral V, Cameron R, Hogg A, Langley N, Barnes I, et al. Comparison of various characteristics of women who do and do not attend for breast cancer screening. *Breast Cancer Research*. 2002;4(1):R1.
134. Weller DP, Patnick J, McIntosh HM, Dietrich AJ. Uptake in cancer screening programmes. *Lancet Oncol*. 2009;10(7):693-9.
135. Renshaw C, Jack RH, Dixon S, Moller H, Davies EA. Estimating attendance for breast cancer screening in ethnic groups in London. *BMC public health*. 2010;10:157.
136. Zackrisson S, Lindström M, Moghaddassi M, Andersson I, Janzon L. Social predictors of non-attendance in an urban mammographic screening programme: A multilevel analysis. *Scandinavian Journal of Social Medicine*. 2007;35(5):548-54.
137. Thomas VN, Saleem T, Abraham R. Barriers to effective uptake of cancer screening among Black and minority ethnic groups. *International journal of palliative nursing*. 2005;11(11):562, 4-71.
138. Sarma EA. Barriers to screening mammography. *Health psychology review*. 2015;9(1):42-62.
139. Szczepura A. Access to health care for ethnic minority populations. *Postgraduate Medical Journal*. 2005;81(953):141.
140. Szczepura A, Price C, Gumber A. Breast and bowel cancer screening uptake patterns over 15 years for UK south Asian ethnic minority populations, corrected for differences in socio-demographic characteristics. *BMC Public Health*. 2008;8 (no pagination)(346).
141. O'Byrne AM, Kavanagh AM, Ugoni A, Diver F. Predictors of non-attendance for second round mammography in an Australian mammographic screening programme. *Journal of Medical Screening*. 2000;7(4):190-4.
142. Rimer BK, Keintz MK, Kessler HB, Engstrom PF, Rosan JR. Why women resist screening mammography: patient-related barriers. *Radiology*. 1989;172(1):243-6.

143. Maxwell AJ, Beattie C, Lavelle J, Lyburn I, Sinnatamby R, Garnett S, et al. The effect of false positive breast screening examinations on subsequent attendance: retrospective cohort study. *Journal of Medical Screening*. 2013;20(2):91-8.
144. Jensen LF, Pedersen AF, Andersen B, Vedsted P. Self-assessed health, perceived stress and non-participation in breast cancer screening: A Danish cohort study. *Preventive Medicine*. 2015;81:392-8.
145. Mitchell AJ, Pereira IE, Yadegarfar M, Pepereke S, Mugadza V, Stubbs B. Breast cancer screening in women with mental illness: comparative meta-analysis of mammography uptake. *The British journal of psychiatry : the journal of mental science*. 2014;205(6):428-35.
146. Lawrence D, Hancock KJ, Kisely S. The gap in life expectancy from preventable physical illness in psychiatric patients in Western Australia: retrospective analysis of population based registers. *Bmj*. 2013;346:f2539.
147. Kisely S, Crowe E, Lawrence D. Cancer-related mortality in people with mental illness. *JAMA psychiatry*. 2013;70(2):209-17.
148. Harris TJ, Cook DG, Shah S, Victor CR, DeWilde S, Beighton C, et al. Mammography uptake predictors in older women. *Family practice*. 2002;19(6):661-4.
149. Speedy S, Hase S. Health beliefs and perceptions of women presenting or not presenting for mammographic screening in a rural health setting. *The Australian journal of rural health*. 2000;8(4):208-13.
150. Carney P, O'Neill S, Ciaran ON. Determinants of breast cancer screening uptake in women, evidence from the British Household Panel Survey. *Social Science & Medicine*. 2013;82(C):108-14.
151. Lagerlund M, Sontrop JM, Zackrisson S. Psychosocial factors and attendance at a population-based mammography screening program in a cohort of Swedish women. *BMC Women's Health*. 2014;14:33-.
152. Drossaert CC, Boer H, Seydel ER. Perceived risk, anxiety, mammogram uptake, and breast self-examination of women with a family history of breast cancer: the role of knowing to be at increased risk. *Cancer Detect Prev*. 1996;20(1):76-85.
153. Hay JL, McCaul KD, Magnan RE. Does worry about breast cancer predict screening behaviors? A meta-analysis of the prospective evidence. *Prev Med*. 2006;42(6):401-8.
154. Sutton S, Bickler G, Sancho-Aldridge J, Saidi G. Prospective study of predictors of attendance for breast cancer screening in inner London. *J Epidemiol Community Health*. 1994;48.
155. Ackerson K, Preston SD. A decision theory perspective on why women do or do not decide to have cancer screening: systematic review. *Journal of advanced nursing*. 2009;65(6):1130-40.
156. Clifton A, Burgess C, Clement S, Ohlsen R, Ramluggun P, Sturt J, et al. Influences on uptake of cancer screening in mental health service users: a qualitative study. *BMC Health Serv Res*. 2016;16:257.
157. Drossaert CHC, Boer H, Seydel ER. Prospective Study on the Determinants of Repeat Attendance and Attendance Patterns in Breast Cancer Screening Using the Theory of Planned Behaviour. *Psychology & Health*. 2003;18(5):551-65.
158. Chouliara Z, Power KG, Swanson V, Johnstone F. Factors associated with breast screening attendance: A controlled comparison between attenders and non-attenders in Scotland. *International Journal of Health Promotion and Education*. 2002;40(3):78-90.
159. Islam RM, Bell RJ, Billah B, Hossain MB, Davis SR. Awareness of breast cancer and barriers to breast screening uptake in Bangladesh: A population based survey. *Maturitas*. 2016;84:68-74.

160. Richards SH, Bankhead C, Peters TJ, Austoker J, Hobbs FD, Brown J, et al. Cluster randomised controlled trial comparing the effectiveness and cost-effectiveness of two primary care interventions aimed at improving attendance for breast screening. *Journal of Medical Screening*. 2001;8(2):91-8.
161. Goel AG, Julie; Burack, Robert;. Telephone reminders increase re-screening in a county breast screening program. *Journal of Health Care for the Poor and Underserved*. 2008;19(2):521.
162. Chaudhry R, Scheitel SM, McMurtry EK, et al. Web-based proactive system to improve breast cancer screening: A randomized controlled trial. *Archives of Internal Medicine*. 2007;167(6):606-11.
163. Zidar MN, Larm P, Tillgren P, Akhavan S. Non-attendance of mammographic screening: the roles of age and municipality in a population-based Swedish sample. *Intern*. 2015;14:157.
164. Marteau TM, Dormandy E, Michie S. A measure of informed choice. *Health expectations : an international journal of public participation in health care and health policy*. 2001;4(2):99-108.
165. Metcalfe D, Price C, Powell J. Media coverage and public reaction to a celebrity cancer diagnosis. *Journal of public health (Oxford, England)*. 2011;33(1):80-5.
166. Taylor-Phillips S, O'Sullivan E, Kearins O, Parsons H, Clarke A. The effects of a UK review of Breast Cancer Screening on Uptake: An observational before/after study. *Journal of Medical Screening*. 2013;20(2):86-90.
167. Euler-Chelpin M, Olsen AH, Njor S, Jensen A, Vejborg I, Schwartz W, et al. Does educational level determine screening participation? *European Journal of Cancer Prevention*. 2008;17(3):273-8.
168. Fleming P, O'Neill S, Owens M, Mooney T, Fitzpatrick P. Intermittent attendance at breast cancer screening. *Journal of Public Health Research*. 2013;2 (2) (no pagination)(e14).
169. Ulcickas Yood M, McCarthy BD, Lee NC, Jacobsen G, Johnson CC. Patterns and characteristics of repeat mammography among women 50 years and older. *Cancer Epidemiol Biomarkers Prev*. 1999;8(7):595-9.
170. Screening and Immunisations Team HSCIC. Breast Screening Programme, England. Statistics for 2015-16. PDF. health and Social Care Information Centre; 2017 February 2017.
171. Vaile MS, Calnan M, Rutter DR, Wall B. Breast cancer screening services in three areas: uptake and satisfaction. *J Public Health Med*. 1993;15(1):37-45.
172. General Medical Council. Consent: patients and doctors making decisions together. UK: General Medical Council; 2008 2008.
173. Mold A. Patients' Rights and the National Health Service in Britain, 1960s–1980s. *American Journal of Public Health*. 2012;102(11):2030-8.
174. NHS; Williams L. The NHS Constitution, the NHS belongs to us all. England: National Health Service, England; 2015 07/27/2015. Contract No.: 2900013.
175. Baines CJ. Mammography Screening: Are Women Really Giving Informed Consent? *JNCI: Journal of the National Cancer Institute*. 2003;95(20):1508-11.
176. Forbes LJJ, Ramirez A-J. Offering informed choice about breast screening. *Journal of Medical Screening*. 2014;21(4):194-200.
177. Mayor S. Critics attack new NHS breast screening leaflet for failing to address harms. *BMJ*. 2010;341:c7267.
178. Osterlie W, Solbjør M, Skolbekken JA, Hofvind S, Saetnan AR, Forsmo S. Challenges of informed choice in organised screening. *Journal of medical ethics*. 2008;34(9):e5.

179. Webster P, Austoker J. Does the English Breast Screening Programme's information leaflet improve women's knowledge about mammography screening? A before and after questionnaire survey. *J Public Health*. 2007;29(2):173-7.
180. Fox R. Informed choice in screening programmes: Do leaflets help? A critical literature review. *J Public Health*. 2006;28(4):309-17.
181. Morris N. When health means suffering: mammograms, pain and compassionate care. *Eur J Cancer Care (Engl)*. 2015;24(4):483-92.
182. Ellins JM, Shirley;. Supporting patients to make informed choices in primary care: what works? Health Services Management Centre: University of Birmingham; 2009 May 2009. Contract No.: HSMC Policy Paper 4.
183. Chiu L. Promoting informed choices on cancer screening in a diverse community. University of Leeds: Institution of Health Sciences; 2009 2009. Contract No.: No.6.
184. Marteau TM, Mann E, Prevost AT, Vasconcelos JC, Kellar I, Sanderson S, et al. Impact of an informed choice invitation on uptake of screening for diabetes in primary care (DICISION): randomised trial. *The BMJ*. 2010;340:c2138.
185. Public Health England. UK NSC: evidence review process Government website: Government; 2016 [updated 09/20/2016. Available from: <https://www.gov.uk/government/publications/uk-nsc-evidence-review-process/uk-nsc-evidence-review-process>.
186. Michie S, Dormandy E, Marteau TM. Informed choice: understanding knowledge in the context of screening uptake. *Patient Education and Counseling*. 2003;50(3):247-53.
187. Reyna VF, Nelson WL, Han PK, Dieckmann NF. How numeracy influences risk comprehension and medical decision making. *Psychological bulletin*. 2009;135(6):943-73.
188. Smith SK, Trevena L, Simpson JM, Barratt A, Nutbeam D, McCaffery KJ. A decision aid to support informed choices about bowel cancer screening among adults with low education: randomised controlled trial. *BMJ*. 2010;341.
189. Gigerenzer G. Towards a paradigm shift in cancer screening: informed citizens instead of greater participation. *BMJ : British Medical Journal*. 2015;350.
190. Berens E-M, Reder M, Razum O, Kolip P, Spallek J. Informed Choice in the German Mammography Screening Program by Education and Migrant Status: Survey among First-Time Invitees. *PLoS One*. 2015;10(11):e0142316.
191. Slovic P, Peters E, Finucane ML, MacGregor DG. Affect, risk, and decision making. *Health psychology*. 2005;24(4S):S35.
192. Barratt A, Trevena L, Davey HM, McCaffery K. Use of decision aids to support informed choices about screening. *BMJ*. 2004;329(7464):507-10.
193. Marteau TM, Johnston M, Plenicar M, Shaw RW, Slack J. Development of a self-administered questionnaire to measure women's knowledge of prenatal screening and diagnostic tests. *Journal of psychosomatic research*. 1988;32(4-5):403-8.
194. Reyna VF. A Theory of Medical Decision Making and Health: Fuzzy Trace Theory. *Medical Decision Making*. 2008;28(6):850-65.
195. Waller J, Douglas E, Whitaker KL, Wardle J. Women's responses to information about overdiagnosis in the UK breast cancer screening programme: a qualitative study. *BMJ Open*. 2013;3(4):e002703.
196. Stefanek ME. Uninformed Compliance or Informed Choice? A Needed Shift in Our Approach to Cancer Screening. *JNCI: Journal of the National Cancer Institute*. 2011;103(24):1821-6.
197. Screening and Immunisations Team ND, ;. Breast Screening Programme. England, 2016-17. NHS Digital; 2018 2018. Contract No.: 1.

198. Schueler KM, Chu PW, Smith-Bindman R. Factors associated with mammography utilization: a systematic quantitative review of the literature. *J Womens Health (Larchmt)*. 2008;17(9):1477-98.
199. Chan D. So why ask me? Are self-report data really that bad. In: Lance C, Vandenberg R, editors. *Statistical and methodological myths and urban legends*. New York: Taylor & Francis; 2009. p. 412.
200. Harrison LD. The Validity of Self-Reported Data on Drug Use. *Journal of Drug Issues*. 1995;25(1):91-111.
201. Haskell WL. Physical activity by self-report: a brief history and future issues. *Journal of Physical Activity and Health*. 2012;9(s1):S5-S10.
202. Jenkins J, ; Public Health England,;. Breast screening: consolidated programme standards. Government website: Public Health England; 2017 April 2017.
203. Screening and Immunisations Team ND, ;. Breast Screening Programme England, 2016-17. Publication appendices. NHS Digital; 2018 4th April 2018. Contract No.: 2.
204. Evans D. Hierarchy of evidence: a framework for ranking evidence evaluating healthcare interventions. *J Clin Nurs*. 2003;12(1):77-84.
205. Booth A, Clarke M, Dooley G, Ghera D, Moher D, Petticrew M, et al. The nuts and bolts of PROSPERO: an international prospective register of systematic reviews. *Systematic Reviews*. 2012;1(1):2.
206. Crosby R, ; Williamson, Sian; Stinton, Chris; Clarke, Aileen; Taylor-Phillips, Sian,;. A systematic review to identify the worldwide predictors of breast screening uptake PROSPERO International prospective register of systematic reviews: University of York; 2016 [Available from: http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42016051597.
207. Hunter JE, Schmidt FL. *Methods of meta-analysis: Correcting error and bias in research findings*: Sage; 2004.
208. Higgins JP, Thompson SG, Spiegelhalter DJ. A re-evaluation of random-effects meta-analysis. *Journal of the Royal Statistical Society: Series A (Statistics in Society)*. 2009;172(1):137-59.
209. DerSimonian R, Kacker R. Random-effects model for meta-analysis of clinical trials: An update. *Contemporary Clinical Trials*. 2007;28(2):105-14.
210. Bellamy L, Casas J-P, Hingorani AD, Williams D. Type 2 diabetes mellitus after gestational diabetes: a systematic review and meta-analysis. *The Lancet*. 2009;373(9677):1773-9.
211. National Collaborating Centre for Methods and Tools. *Quality Assessment Tool for Quantitative Studies*: McMaster University; 2008 [updated 13th April 2010; cited 2017 27th June 2017]. Available from: <http://www.nccmt.ca/resources/search/14>.
212. Tomlin G, Borgetto B. Research Pyramid: A New Evidence-Based Practice Model for Occupational Therapy. *American Journal of Occupational Therapy*. 2011;65(2):189-96.
213. Hayden JA, van der Windt DA, Cartwright JL, Côté P, Bombardier C. Assessing bias in studies of prognostic factors. *Annals of internal medicine*. 2013;158(4):280-6.
214. Hayden JA, Côté P, Bombardier C. Evaluation of the quality of prognosis studies in systematic reviews. *Annals of internal medicine*. 2006;144(6):427-37.
215. Effective Public Health Practice Project. *Quality Assessment Tool for Quantitative Studies* <http://www.ehphp.ca/index.html>: Hamilton, ON; 1998 [Tool - Data abstraction]. Available from: <http://www.ehphp.ca/index.html>.
216. Armijo-Olivo S, Stiles CR, Hagen NA, Biondo PD, Cummings GG. Assessment of study quality for systematic reviews: a comparison of the Cochrane Collaboration Risk of Bias Tool and the Effective Public Health Practice Project Quality

- Assessment Tool: methodological research. *Journal of Evaluation in Clinical Practice*. 2012;18(1):12-8.
217. McCarty CA, Chyou PH, Greenlee R, McCarty DJ, Gunderson P, Reding D. Differences in preventive screening rates in Wisconsin farm and non-farm resident women. *Wisconsin Medical Journal*. 2003;102(5):22-6.
 218. Higgins JPTG, S. Front Matter. *Cochrane Handbook for Systematic Reviews of Interventions* 2008.
 219. Cheng HG, Phillips MR. Secondary analysis of existing data: opportunities and implementation. *Shanghai Archives of Psychiatry*. 2014;26(6):371-5.
 220. Chang Y, Cho B, Son KY, Shin DW, Shin H, Yang H-K, et al. Determinants of gastric cancer screening attendance in Korea: a multi-level analysis. *BMC Cancer*. 2015;15(336).
 221. Rasbash J, Steele F, Browne WJ, Goldstein H. *A User's Guide to MLwiN*. United Kingdom: University of Bristol; 2009.
 222. Rowley J. Designing and using research questionnaires. *Management Research Review*. 2014;37(3):308-30.
 223. Grimm P. Social Desirability Bias. *Wiley International Encyclopedia of Marketing*: John Wiley & Sons, Ltd; 2010.
 224. Kreuter F, Presser S, Tourangeau R. Social Desirability Bias in CATI, IVR, and Web Surveys The Effects of Mode and Question Sensitivity. *Public Opinion Quarterly*. 2008;72(5):847-65.
 225. Nederhof AJ. Methods of coping with social desirability bias: A review. *European Journal of Social Psychology*. 1985;15(3):263-80.
 226. Randall DM, Fernandes MF. The social desirability response bias in ethics research. *Journal of Business Ethics*. 1991;10(11):805-17.
 227. Fisher RJ. Social Desirability Bias and the Validity of Indirect Questioning. *Journal of Consumer Research*. 1993;20(2):303-15.
 228. Armstrong JS, Overton TS. Estimating Nonresponse Bias in Mail Surveys. *Journal of Marketing Research*. 1977;14(3):396-402.
 229. Wedderburn C, Rickenbach M. Questionnaires, questionnaires. *BMJ*. 2011;342:d3124.
 230. Dormandy E, Tsui EYL, Marteau TM. Development of a measure of informed choice suitable for use in low literacy populations. *Patient Education and Counseling*. 2007;66(3):278-95.
 231. Fincham JE. Response rates and responsiveness for surveys, standards, and the Journal. *American journal of pharmaceutical education*. 2008;72(2):43-.
 232. Lietz P. Research into questionnaire design. A summary of the literature. *International Journal of Market Reserach*. 2010;52(2):249.
 233. Dormandy E, Michie S, Hooper R, Marteau TM. Informed choice in antenatal Down syndrome screening: A cluster-randomised trial of combined versus separate visit testing. *Patient Education and Counseling*. 2006;61(1):56-64.
 234. Michie S, Dormandy E, Marteau TM. The multi-dimensional measure of informed choice: a validation study. *Patient Education and Counseling*. 2002;48(1):87-91.
 235. Mathieu E, Barratt A, Davey HM, McGeechan K, Howard K, Houssami N. Informed choice in mammography screening: A randomized trial of a decision aid for 70-year-old women. *Archives of Internal Medicine*. 2007;167(19):2039-46.
 236. Mathieu E, Barratt AL, McGeechan K, Davey HM, Howard K, Houssami N. Helping women make choices about mammography screening: an online randomized trial of a decision aid for 40-year-old women. *Patient Educ Couns*. 2010;81(1):63-72.
 237. Beatty PC, Willis GB. Research Synthesis: The Practice of Cognitive Interviewing. *Public Opinion Quarterly*. 2007;71(2):287-311.

238. Miller K, Chepp V, Willson S, Padilla JL. Cognitive Interviewing Methodology: Wiley; 2014.
239. Willis GB. Cognitive interviewing: A tool for improving questionnaire design: Sage Publications; 2004.
240. Drennan J. Cognitive interviewing: verbal data in the design and pretesting of questionnaires. *Journal of advanced nursing*. 2003;42(1):57-63.
241. Pepper D, Hodgen J, Lamesoo K, Kõiv P, Tolboom J. Think aloud: using cognitive interviewing to validate the PISA assessment of student self-efficacy in mathematics. *International Journal of Research & Method in Education*. 2018;41(1):3-16.
242. Ericsson KA, Simon HA. Protocol analysis: Verbal reports as data: the MIT Press; 1984.
243. Leighton JP. Avoiding misconception, misuse, and missed opportunities: The collection of verbal reports in educational achievement testing. *Educational Measurement: Issues and Practice*. 2004;23(4):6-15.
244. Stroup DF, Berlin JA, Morton SC, et al. Meta-analysis of observational studies in epidemiology: A proposal for reporting. *JAMA*. 2000;283(15):2008-12.
245. Moher D, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med*. 2009;6.
246. Quinn M, Allen E, Registries UKAoC. Changes in incidence of and mortality from breast cancer in England and Wales since introduction of screening. *British Medical Journal*. 1995;311:1391-5.
247. Walker MJ, Chiarelli AM, Mirea L, Glendon G, Ritvo P, Andrulis IL, et al. Accuracy of Self-Reported Screening Mammography Use: Examining Recall among Female Relatives from the Ontario Site of the Breast Cancer Family Registry. *ISRN Oncology*. 2013;2013:9.
248. Bansal N, Bhopal RS, Steiner MFC, Brewster DH. Major ethnic group differences in breast cancer screening uptake in Scotland are not extinguished by adjustment for indices of geographical residence, area deprivation, long-term illness and education. *British Journal of Cancer*. 2012;106(8):1361-6.
249. Chiarelli AM, Mai V, Moravan V, Halapy E, Majpruz V, Tatla RK. False-Positive Result and Reattendance in the Ontario Breast Screening Program. *Journal of Medical Screening*. 2003;10(3):129-33.
250. Liu BY, O'Malley J, Mori M, Fagnan LJ, Lieberman D, Morris CD, et al. The Association of Type and Number of Chronic Diseases with Breast, Cervical and Colorectal Cancer Screening in Rural Primary Care Practices. *Journal of the American Board of Family Medicine : JABFM*. 2014;27(5):669-81.
251. Pinckney RG, Geller BM, Burman M, Littenberg B. Effect of false-positive mammograms on return for subsequent screening mammography. *The American Journal of Medicine*. 2003;114(2):120-5.
252. Vermeer BVdM, Maria;. The attendance of migrant women at the national breast cancer screening in the Netherlands 1997-2008. *European Journal of Cancer Prevention*. 2010;19:195-8.
253. Shapiro SC, Elizabeth Ann; Broeders, Mireille; Codd, Mary; Koning, Harry de; Fracheboud, Jacques; Moss, Sue; Paci, Eugenio; Stachenko, Sylvie, Ballard-Barbash, Rachel; International Breast Cancer Screening Network and European Network of Pilot Projects for Breast Cancer Screening. Breast cancer screening programmes in 22 countries: current policies, administration and guidelines. *International Epidemiological Association*. 1998;27:735-42.
254. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ*. 2009;339.

255. Tatla RK, Paszat LF, Bondy SJ, Chen Z, Chiarelli AM, Mai V. Socioeconomic status & returning for a second screen in the Ontario breast screening program. *Breast*. 2003;12(4):237-46.
256. Thomas BH, Ciliska D, Dobbins M, Micucci S. A Process for Systematically Reviewing the Literature: Providing the Research Evidence for Public Health Nursing Interventions. *Worldviews on Evidence-Based Nursing*. 2004;1(3):176-84.
257. StataCorp;. *Stata Statistical Software: Release 15*. 15.1 ed. College Station, Texas, USA;: StataCorp LLP; 2017.
258. Community; C. *Review Manager (RevMan)*. 5.3 ed. Copenhagen: The Nordic Cochrane Centre: The Cochrane Collaboration, 2014; 2014.
259. Valentine JCP, Therese. D.; Rothstein, Hannah. R.;. How many studies do you need? A primer on statistical power for meta-analysis. *Journal of Educational and Behavioural Statistics*. 2010;35(2):215-47.
260. Bland JM, Altman DG. Multiple significance tests: the Bonferroni method. *BMJ*. 1995;310(6973):170.
261. Abdi H. Bonferroni and Sidak corrections for multiple comparisons. 1 ed. Salkind N, editor. Thousand Oaks (California): Sage; 2007 2007.
262. Andersen SB, Vejborg I, von Euler-Chelpin M. Participation behaviour following a false positive test in the Copenhagen mammography screening programme. *Acta Oncol*. 2008;47(4):550-5.
263. Beaber EF, Tosteson ANA, Haas JS, Onega T, Sprague BL, Weaver DL, et al. Breast cancer screening initiation after turning 40 years of age within the PROSPR consortium. *Breast Cancer Research and Treatment*. 2016;160(2):323-31.
264. Berens EM, Stahl L, Yilmaz-Aslan Y, Sauzet O, Spallek J, Razum O. Participation in breast cancer screening among women of Turkish origin in Germany - a register-based study. *BMC Women's Health*. 2014;14 (1) (no pagination)(24).
265. Bourmaud A, Soler-Michel P, Oriol M, Regnier V, Tinquaut F, Nourissat A, et al. Decision aid on breast cancer screening reduces attendance rate: Results of a large-scale, randomized, controlled study by the DECIDEO group. *Oncotarget*. 2016;7(11):12885-92.
266. Bulliard J, De Landtsheer J, Levi F. Reattendance in the Swiss mammography screening pilot programme. *Journal of Medical Screening*. 2004;11(2):59-64.
267. Carney PA, Goodrich ME, MacKenzie T, Weiss JE, Poplack SP, Wells WS, et al. Utilization of screening mammography in New Hampshire - A population-based assessment. *Cancer*. 2005;104(8):1726-32.
268. Ferrante JM, Chen PH, Jacobs A. Breast and cervical cancer screening in obese minority women. *J Womens Health (Larchmt)*. 2006;15(5):531-41.
269. Fitzpatrick P, Fleming P, O'Neill S, Kiernan D, Mooney T. False-positive mammographic screening: factors influencing re-attendance over a decade of screening. *Journal of Medical Screening*. 2011;18(1):30-3.
270. Gandhi S, Rovi S, Vega M, Johnson MS, Ferrante J, Chen PH. Intimate partner violence and cancer screening among urban minority women. *J Am Board Fam Med*. 2010;23(3):343-53.
271. Gatrell A, Garnett S, Rigby J, Maddocks A, Kirwan M. Uptake of screening for breast cancer in south Lancashire. *Public Health (Nature)*. 1998;112(5):297-301.
272. Giordano L, Giorgi D, Piccini P, Ventura L, Stefanini V, Senore C, et al. Time trends of process and impact indicators in Italian breast screening programmes--1996-2005. *Epidemiol Prev*. 2008;32(2 Suppl 1):23-36.
273. Giorgi D, Giordano L, Senore C, Merlino G, Negri R, Cancian M, et al. General practitioners and mammographic screening uptake: influence of different

- modalities of general practitioner participation. Working Group. *Tumori*. 2000;86(2):124-9.
274. Gregory-Mercado KY, Will J, True S, Royalty J, Starcher 2nd ET, Khavjou O, et al. A combined approach to women's health is associated with a greater likelihood of repeat mammography in a population of financially disadvantaged women. *Preventing chronic disease*. 2007;4(4):A89.
 275. Hurley SF, Huggins RM, Jolley DJ, Reading D. Recruitment activities and sociodemographic factors that predict attendance at a mammographic screening program. *American Journal of Public Health*. 1994;84(10):1655-8.
 276. Hyndman JCG, Holman CDJ, Dawes VP. Effect of distance and social disadvantage on the response to invitations to attend mammography screening. *Journal of Medical Screening*. 2000;7(3):141-5.
 277. Jean S, Major D, Rochette L, Brisson J. Screening mammography participation and invitational strategy: The Quebec Breast Cancer Screening Program, 1998 - 2000. *Chronic Diseases in Canada*. 2005;26(2-3):52-8.
 278. Jensen LF, Pedersen AF, Andersen B, Vedsted P. Identifying specific non-attending groups in breast cancer screening - population-based registry study of participation and socio-demography. *BMC Cancer*. 2012;12 (no pagination)(518).
 279. Jensen LF, Mukai TO, Andersen B, Vedsted P. The association between general practitioners' attitudes towards breast cancer screening and women's screening participation. *Bmc Cancer*. 2012;12:6.
 280. Jensen LF, Pedersen AF, Andersen B, Vedsted P. Social support and non-participation in breast cancer screening: a Danish cohort study. *J Public Health*. 2016;38(2):335-42.
 281. Kee F, Telford AM, Donaghy P, O'Doherty A. Enhancing mammography uptake: who do women listen to? *European Journal of Cancer Prevention*. 1993;2(1):37-42.
 282. Kinnear H, Connolly S, Rosato M, Hall C, Mairs A, O'Reilly D. Are caregiving responsibilities associated with non-attendance at breast screening? *BMC Public Health*. 2010;10(1):749.
 283. Kinnear H, Rosato M, Mairs A, Hall C, O'Reilly D. The low uptake of breast screening in cities is a major public health issue and may be due to organisational factors: A Census-based record linkage study. *The Breast*. 2011;20(5):460-3.
 284. Lim SM, Lee HY, Choi KS, Jun JK, Park EC, Kim Y, et al. Trends of Mammography Use in a National Breast Cancer Screening Program, 2004-2008. *Cancer Res Treat*. 2010;42(4):199-202.
 285. Lagerlund M, Merlo J, Vicente RP, Zackrisson S. Does the Neighborhood Area of Residence Influence Non-Attendance in an Urban Mammography Screening Program? A Multilevel Study in a Swedish City. *PLoS One*. 2015;10(10):21.
 286. Leung J, Macleod C, McLaughlin D, Woods LM, Henderson R, Watson A, et al. Screening mammography uptake within Australia and Scotland in rural and urban populations. *Preventive Medicine Reports*. 2015;2:559-62.
 287. Makedonov I, Gu S, Paszat LF. Organized breast screening improves reattendance compared to physician referral: A case control study. *BMC Cancer*. 2015;15 (1) (no pagination)(315).
 288. Matson S, Andersson I, Berglund G, Janzon L, Manjer J. Nonattendance in mammographic screening: A study of intraurban differences in Malmo, Sweden, 1990-1994. *Cancer Detect Prev*. 2001;25(2):132-7.
 289. May DS, Kiefe CI, Funkhouser E, Fouad MN. Compliance with mammography guidelines: Physician recommendation and patient adherence. *Preventive Medicine*. 1999;28(4):386-94.

290. Mayer JA, Clapp EJ, Bartholomew S, Elder J. Facility-based inreach strategies to promote annual mammograms. *American Journal of Preventive Medicine*. 1994;10(6):353-6.
291. McCann J, Stockton D, Godward S. Impact of false-positive mammography on subsequent screening attendance and risk of cancer. *Breast cancer research : BCR*. 2002;4(5):R11.
292. McCarthy BD, Yood MU, MacWilliam CH, Lee MJ. Screening mammography use: The importance of a population perspective. *American Journal of Preventive Medicine*. 1996;12(2):91-5.
293. Meguerditchian AN, Dauphinee D, Girard N, Eguale T, Riedel K, Jacques A, et al. Do physician communication skills influence screening mammography utilization? *BMC Health Serv Res*. 2012;12:219.
294. Meldrum P, Turnbull D, Dobson HM, Colquhoun C, Gilmour WH, McIlwaine GM. Tailored written invitations for second round breast cancer screening: a randomised controlled trial. *Journal of medical screening*. 1994;1(4):245-8.
295. Moss SM, Brown J, Garvican L, Coleman DA, Johns LE, Blanks RG, et al. Routine breast screening for women aged 65-69: results from evaluation of the demonstration sites. *British Journal of Cancer*. 2001;85(9):1289-94.
296. Norum J, Hofvind S, Nieder C, Schnell EA, Broderstad AR. Mammographic screening in Sami speaking municipalities and a control group. Are early outcome measures influenced by ethnicity? *International journal of circumpolar health*. 2012;71:1-6.
297. Offman J, Wilson M, Lamont M, Birke H, Kutt E, Marriage S, et al. A randomised trial of weekend and evening breast screening appointments. *British Journal of Cancer*. 2013;109(3):597-602.
298. Oh D, Jung da W, Jun JK, Jung KW, Lee HY, Park EC, et al. On-schedule mammography rescreening in the National Cancer Screening Program for breast cancer in Korea. *Asian Pac J Cancer Prev*. 2011;12(11):2865-70.
299. Ore L, Hagoel L, Shifroni G, Rennert G. Compliance with mammography screening in Israeli women: The impact of a pre-scheduled appointment and of the letter-style. *Israel Journal of Medical Sciences*. 1997;33(2):103-11.
300. O'Reilly D, Kinnear H, Rosato M, Mairs A, Hall C. Using record linkage to monitor equity and variation in screening programmes. *BMC medical research methodology*. 2012;12:59.
301. Otten JDM, Van Dijck JAAM, Peer PGM, Straatman H, Verbeek ALM, Mravunac M, et al. Long term breast cancer screening in Nijmegen, The Netherlands: The nine rounds from 1975-92. *Journal of Epidemiology and Community Health*. 1996;50(3):353-8.
302. Page A, Morrell S, Chiu C, Taylor R, Tewson R. Recruitment to mammography screening: a randomised trial and meta-analysis of invitation letters and telephone calls. *Australian & New Zealand Journal of Public Health*. 2006;30(2):111-8.
303. Peeters PHM, Verbeek ALM, Hendriks JHCL, Van Bon MJH. Screening for breast cancer in Nijmegen. Report of 6 screening rounds, 1975-1986. *International Journal of Cancer*. 1989;43(2):226-30.
304. Peeters PH, Beckers CG, Hogervorst JM, Collette HJ. Effect on breast cancer screening response in The Netherlands of inviting women for an additional scientific investigation. *Journal of Epidemiology & Community Health*. 1994;48(2):175-7.
305. Pelfrene ER, Bleyen L, De Backer G. Uptake in breast cancer screening - A sociogeographical analysis. *Eur J Public Health*. 1998;8(2):146-9.

306. Rodriguez C, Plasencia A, Schroeder DG. Predictive factors of enrollment and adherence in a breast cancer screening program in Barcelona (Spain). *Social Science & Medicine*. 1995;40(8):1155-60.
307. Rutten LJF, Ebbert JO, Jacobson DJ, Squiers LB, Fan C, Breitkopf CR, et al. Changes in US Preventive Services Task Force recommendations: Effect on mammography screening in Olmsted County, MN 2004-2013. *Preventive Medicine*. 2014;69:235-8.
308. Rutter DR, Calnan M, Field S, Vaile MSB. Predicting reattendance in the second round of the UK National Breast Screening Programme: A prospective 3-year longitudinal analysis. *Breast*. 1997;6(3):120-5.
309. Seeley T. Do women taking hormone replacement therapy have a higher uptake of screening mammograms? *Maturitas*. 1994;19(2):93-6.
310. Segnan N, Senore C, Giordano L, Ponti A, Ronco G. Promoting participation in a population screening program for breast and cervical cancer: A randomized trial of different invitation strategies. *Tumori*. 1998;84(3):348-53.
311. Shippee ND, Mullan RJ, Nabhan M, Kermott CA, Hagen PT, Rhodes DJ, et al. Adherence to Preventive Recommendations: Experience of a Cohort Presenting for Executive Health Care. *Popul Health Manag*. 2012;15(2):65-70.
312. Simon MS, Gimotty PA, Moncrease A, Dews P, Burack RC. The effect of patient reminders on the use of screening mammography in an urban health department primary care setting. *Breast Cancer Res Treat*. 2001;65(1):63-70.
313. St-Jacques S, Philibert MD, Langlois A, Daigle JM, Pelletier E, Major D, et al. Geographic access to mammography screening centre and participation of women in the Quebec Breast Cancer Screening Programme. *Journal of Epidemiology and Community Health*. 2013;67(10):861-7.
314. Taplin SH, Anderman C, Grothaus L, Curry S, Montano D. Using physician correspondence and postcard reminders to promote mammography use. *American Journal of Public Health*. 1994;84(4):571-4.
315. Taylor V, Thompson B, Lessler D, Yasui Y, Montano D, Johnson KM, et al. A clinic-based mammography intervention targeting inner-city women. *Journal of General Internal Medicine*. 1999;14(2):104-11.
316. Tornberg S, Kemetli L, Svane G, Rosen M, Nystrom L. Pattern of participation in a cohort aged 50-60 years at first invitation to the service-screening programme with mammography in Stockholm county, Sweden. *Preventive Medicine*. 2005;41(3-4):728-33.
317. Valanis B, Whitlock EE, Mullooly J, Vogt T, Smith S, Chen C, et al. Screening rarely screened women: time-to-service and 24-month outcomes of tailored interventions. *Preventive Medicine*. 2003;37(5):442-50.
318. Vidal C, Garcia M, Benito L, Mila N, Binefa G, Moreno V. Use of text-message reminders to improve participation in a population-based breast cancer screening program. *Journal of Medical Systems*. 2014;38 (9) (no pagination)(118).
319. Visser O, Van Peppen AM, Ory FG, Van Leeuwen FE. Results of breast cancer screening in first generation migrants in Northwest Netherlands. *European Journal of Cancer Prevention*. 2005;14(3):251-5.
320. von Euler-Chelpin M, Olsen AH, Njor S, Vejborg I, Schwartz W, Lynge E. Socio-demographic determinants of participation in mammography screening. *International Journal of Cancer*. 2008;122(2):418-23.
321. Wilf-Miron R, Peled R, Yaari E, Vainer A, Porath A, Kokia E. The association between socio-demographic characteristics and adherence to breast and colorectal cancer screening: Analysis of large sub populations. *BMC Cancer*. 2011;11 (no pagination)(376).

322. Werneke U, Horn O, Maryon-Davis A, Wessely S, Donnan S, McPherson K. Uptake of screening for breast cancer in patients with mental health problems. *Journal of Epidemiology & Community Health*. 2006;60(7):600-5.
323. Williams EM, Vessey MP. Randomised trial of two strategies offering women mobile screening for breast cancer. *BMJ (Clinical research ed)*. 1989;299(6692):158-9.
324. Woodhead C, Cunningham R, Ashworth M, Barley E, Stewart RJ, Henderson MJ. Cervical and breast cancer screening uptake among women with serious mental illness: a data linkage study. *Bmc Cancer*. 2016;16:9.
325. Yarnall KS, Michener JL, Broadhead WE, Tse CK. Increasing compliance with mammography recommendations: health assessment forms. *J*. 1993;36(1):59-64.
326. Jensen LF, Pedersen AF, Andersen B, Vestergaard M, Vedsted P. Non-participation in breast cancer screening for women with chronic diseases and multimorbidity: A population-based cohort study. *BMC Cancer*. 2015;15 (1) (no pagination)(798).
327. Han PKJ, Kobrin SC, Klein WMP, Davis WW, Stefanek M, Taplin SH. Perceived ambiguity about screening mammography recommendations: Association with future mammography uptake and perceptions. *Cancer Epidemiology Biomarkers and Prevention*. 2007;16(3):458-66.
328. Rahman SM, Dignan MB, Shelton BJ. Factors influencing adherence to guidelines for screening mammography among women aged 40 years and older. *Ethn Dis*. 2003;13(4):477-84.
329. Mayer JA, Lewis EC, Slymen DJ, Dillum J, Kurata H, Holbrook A, et al. Patient reminder letters to promote annual mammograms: a randomized controlled trial. *Preventive Medicine*. 2000;31(4):315-22.
330. Hafslund B, Espehaug B, Nortvedt MW. Health-related quality of life, anxiety and depression related to mammography screening in Norway. *J Clin Nurs*. 2012;21(21-22):3223-34.
331. O'Reilly D, Kinnear H, Rosato M, Mairs A, Hall C. Uptake of breast screening is influenced by current religion and religion of upbringing. *J Relig Health*. 2013;52(4):1168-76.
332. Merrick EL, Hodgkin D, Horgan CM, Lorenz LS, Panas L, Ritter GA, et al. Testing Novel Patient Financial Incentives to Increase Breast Cancer Screening. *Am J Manag Care*. 2015;21(11):771-9.
333. Drossaert CH, Boer H, Seydel ER. Monitoring women's experiences during three rounds of breast cancer screening: results from a longitudinal study. *Journal of Medical Screening*. 2002;9(4):168-75.
334. Margolis KL, Menart TC. A test of two interventions to improve compliance with scheduled mammography appointments. *Journal of General Internal Medicine*. 1996;11(9):539-41.
335. Romaine MA, Bowles EJ, Anderson ML, Buist DS. Comparative effectiveness of mailed reminder letters on mammography screening compliance. *Preventive Medicine*. 2012;55(2):127-30.
336. Patnick J. Overview of recent changes to the National Health Service Breast Screening Programme (NHSBSP): impact on the service. *Breast Cancer Research : BCR*. 2004;6(Suppl 1):P28-P.
337. Psaki SR, Seidman JC, Miller M, Gottlieb M, Bhutta ZA, Ahmed T, et al. Measuring socioeconomic status in multicountry studies: results from the eight-country MAL-ED study. *Population health metrics*. 2014;12(1):8-.
338. Galobardes B, Shaw M, Lawlor DA, Lynch JW, Davey Smith G. Indicators of socioeconomic position (part 1). *Journal of epidemiology and community health*. 2006;60(1):7-12.

339. Minton J. Real geographies and virtual landscapes: Exploring the influence on place and space on mortality Lexis surfaces using shaded contour maps. *Spatial and Spatio-temporal Epidemiology*. 2014;10:49-66.
340. Weller DP, Campbell C. Uptake in cancer screening programmes: a priority in cancer control. *Br J Cancer*. 2009;101.
341. Rakowski W, Breen N, Meissner H, Rimer BK, Vernon SW, Clark MA, et al. Prevalence and correlates of repeat mammography among women aged 55-79 in the Year 2000 National Health Interview Survey. *Prev Med*. 2004;39(1):1-10.
342. Anagnostopoulos F, Dimitrakaki C, Fitzsimmons D, Potamianos G, Niakas D, Tountas Y. Health Beliefs and Illness Perceptions as Related to Mammography Uptake in Randomly Selected Women in Greece. *Journal of Clinical Psychology in Medical Settings*. 2012;19(2):147-64.
343. Paskett ED, McMahon K, Tatum C, Velez R, Shelton B, Case LD, et al. Clinic-based interventions to promote breast and cervical cancer screening. *Prev Med*. 1998;27(1):120-8.
344. Selvin E, Brett KM. Breast and cervical cancer screening: sociodemographic predictors among White, Black, and Hispanic women. *American journal of public health*. 2003;93(4):618-23.
345. Schofield PE, Cockburn J, Hill DJ, Reading D. Encouraging attendance at a screening mammography programme: determinants of response to different recruitment strategies. *Journal of medical screening*. 1994;1(3):144-9.
346. Campbell J, Jones A, Dienemann J, et al. Intimate partner violence and physical health consequences. *Archives of Internal Medicine*. 2002;162(10):1157-63.
347. Suter LG, Nakano CY, Elmore JG, Jowsh, medicine g-b. The personal costs and convenience of screening mammography. 2002;11(7):667-72.
348. Rojas M, Mandelblatt J, Cagney K, Icerner J, Freeman H, Ethnicity TCCoHJ, et al. Barriers to follow-up of abnormal screening mammograms among low-income minority women. 1996;1(3):221-8.
349. Scarinci I, Bandura L, Brooke C, Garces I. Breast and Cervical Cancer Screening among Latina Immigrants: How Can We Do It Better? 2006.
350. Bekker H, Morrison L, Marteau TM. Breast screening: GPs' beliefs, attitudes and practices. *Family practice*. 1999;16(1):60-5.
351. O'Reilly D, Connolly S, Rosato M, Patterson C. Is caring associated with an increased risk of mortality? A longitudinal study. *Social science & medicine* (1982). 2008;67.
352. Banning M. Black women and breast health: A review of the literature. *European Journal of Oncology Nursing*. 2011;15(1):16-22.
353. Crawford J, Ahmad F, Beaton D, Bierman AS. Cancer screening behaviours among South Asian immigrants in the UK, US and Canada: a scoping study. *Health & Social Care in the Community*. 2016;24(2):123-53.
354. Jüni P, Altman DG, Egger M. Assessing the quality of controlled clinical trials. *BMJ : British Medical Journal*. 2001;323(7303):42-6.
355. Bartolucci AA, Hillegass WB. Overview, Strengths, and Limitations of Systematic Reviews and Meta-Analyses. In: Chiappelli F, editor. *Evidence-Based Practice: Toward Optimizing Clinical Outcomes*. Berlin, Heidelberg: Springer Berlin Heidelberg; 2010. p. 17-33.
356. Chien PFW, Khan KS, Siassakos D. Registration of systematic reviews: PROSPERO. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2012;119(8):903-5.
357. Biondi-Zoccai G, Lotrionte M, Landoni G, Modena MG. The rough guide to systematic reviews and meta-analyses. *HSR Proceedings in Intensive Care & Cardiovascular Anesthesia*. 2011;3(3):161-73.

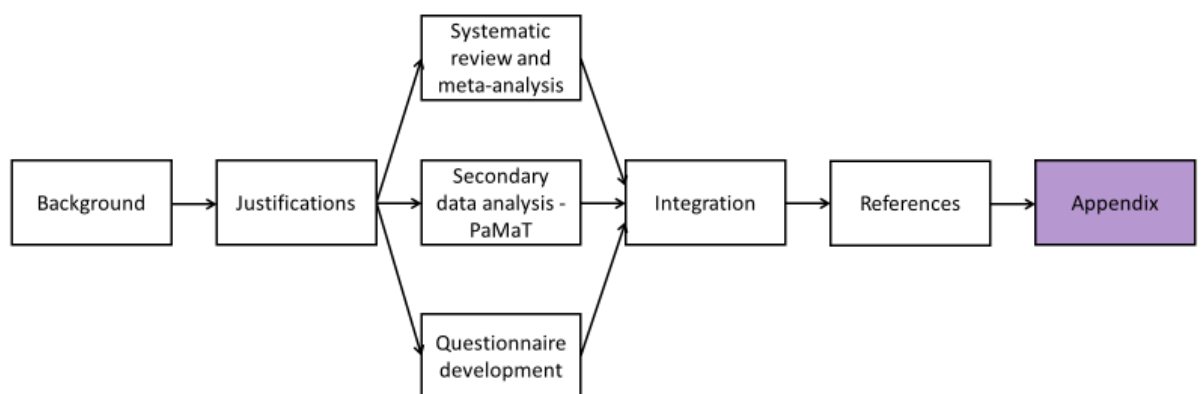
358. Armstrong K, Long JA, Shea JA. Measuring adherence to mammography screening recommendations among low-income women. *Prev Med.* 2004;38(6):754-60.
359. Butler JS, Burkhauser RV, Mitchell JM, Pincus TP. Measurement Error in Self-Reported Health Variables. *The Review of Economics and Statistics.* 1987;69(4):644-50.
360. Ministry of Housing CLGM. Indices of Deprivation 2015 London Datastore,; London Datastore,; 2015 [Available from: <https://data.london.gov.uk/dataset/indices-of-deprivation-2015>].
361. Roderick JAL. A Test of Missing Completely at Random for Multivariate Data with Missing Values. *Journal of the American Statistical Association.* 1988;83(404):1198-202.
362. Howell D. The treatment of missing data. In: Outhwaite W, Turner S, editors. *The SAGE handbook of social science methodology*: SAGE; 2007. p. 640.
363. Acock AC. *A Gentle Introduction to Stata*. United States of America: Stata Press;; 2016.
364. Posada D, Crandall KA. MODELTEST: testing the model of DNA substitution. *Bioinformatics.* 1998;14(9):817-8.
365. Posada D, Buckley TR. Model Selection and Model Averaging in Phylogenetics: Advantages of Akaike Information Criterion and Bayesian Approaches Over Likelihood Ratio Tests. *Systematic Biology.* 2004;53(5):793-808.
366. Potter-Collins AOfNS, ;. 2011 Census analysis: Ethnicity and the Labour market, England and Wales. Data release. Office for National Statistics; 2014 14.11.14.
367. ONS,;. People, population and community Office for National Statistics: Office for national Statistics; 2014 [Datasets]. Available from: <https://www.ons.gov.uk/peoplepopulationandcommunity>.
368. Swets JA. Measuring the accuracy of diagnostic systems. *Science.* 1988;240(4857):1285-93.
369. Domingos P. The role of Occam's razor in knowledge discovery. *Data mining and knowledge discovery.* 1999;3(4):409-25.
370. Williams BA, Lindquist K, Sudore RL, Covinsky KE, Walter LC. Screening mammography in older women. Effect of wealth and prognosis. *Arch Intern Med.* 2008;168.
371. Maheswaran R, Pearson T, Jordan H, Black D. Socioeconomic deprivation, travel distance, location of service, and uptake of breast cancer screening in North Derbyshire, UK. *Journal of Epidemiology and Community Health.* 2006;60(3):208-12.
372. Brewer NT, Salz T, Lillie SE. Systematic review: the long-term effects of false-positive mammograms. *Annals of internal medicine.* 2007;146(7):502-10.
373. Sim MJ, Siva SP, Ramli IS, Fritschi L, Tresham J, Wylie EJ. Effect of false-positive screening mammograms on rescreening in Western Australia. *Med J Aust.* 2012;196(11):693-5.
374. Makuc DM, Breen N, Freid V. Low income, race, and the use of mammography. *Health Services Research.* 1999;34(1 Pt 2):229.
375. O'Sullivan IS, S; Dixon, S; Perry, N;. False positive results do not have a negative effect on reattendance for subsequent breast screening. *Journal of Medical Screening.* 2001;8(3):145-8.
376. Ryan R, Vernon S, Lawrence G, Wilson S. Use of name recognition software, census data and multiple imputation to predict missing data on ethnicity: application to cancer registry records. *BMC medical informatics and decision making.* 2012;12(1):3.

377. Health and Social Care Information Centre. Breast Screening Programme, England, 2016-17. PDF. NHS Digital: NHS Digital; 2018 31 January 2018.
378. Krosnick JA. Questionnaire Design. In: Vannette DL, Krosnick JA, editors. *The Palgrave Handbook of Survey Research*. Cham: Springer International Publishing; 2018. p. 439-55.
379. McCaul KD, Branstetter AD, Schroeder DM, Glasgow RE. What is the relationship between breast cancer risk and mammography screening? A meta-analytic review. *Health psychology : official journal of the Division of Health Psychology, American Psychological Association*. 1996;15(6):423-9.
380. Katapodi MC, Lee KA, Facione NC, Dodd MJ. Predictors of perceived breast cancer risk and the relation between perceived risk and breast cancer screening: a meta-analytic review. *Preventive Medicine*. 2004;38(4):388-402.
381. Vernon SW. Risk Perception and Risk Communication for Cancer Screening Behaviors: a Review. *JNCI Monographs*. 1999;1999(25):101-19.
382. Artino AR, Jr., La Rochelle JS, Dezee KJ, Gehlbach H. Developing questionnaires for educational research: AMEE Guide No. 87. *Medical teacher*. 2014;36(6):463-74.
383. Stone DH. Design a questionnaire. *British Medical Journal*. 1993;307(6914):1264-6.
384. Barlow WE, White E, Ballard-Barbash R, Vacek PM, Titus-Ernstoff L, Carney PA. Prospective breast cancer risk prediction model for women undergoing screening mammography. *J Natl Cancer Inst*. 2006;98.
385. Krishnan K, Baglietto L, Stone J, Simpson JA, Severi G, Evans CF, et al. Longitudinal Study of Mammographic Density Measures That Predict Breast Cancer Risk. *Cancer Epidemiology Biomarkers & Prevention*. 2017;26(4):651-60.
386. Zhang X, Rice M, Tworoger SS, Rosner BA, Eliassen AH, Tamimi RM, et al. Abstract 2600: Improving breast cancer risk prediction models: the addition of a genetic risk score, mammographic density, and endogenous hormones. *Cancer Research*. 2016;76(14 Supplement):2600-.
387. National Cancer Institute. Breast Cancer Risk Prediction Models NIH: NIH; 2018 [updated 01.02.2018. Available from: https://epi.grants.cancer.gov/cancer_risk_prediction/breast.html#other.
388. Benos DJ, Bashari E, Chaves JM, Gaggar A, Kapoor N, LaFrance M, et al. The ups and downs of peer review. *Advances in Physiology Education*. 2007;31(2):145-52.
389. Matsuno RK, Costantino JP, Ziegler RG, Anderson GL, Li H, Pee D, et al. Projecting individualized absolute invasive breast cancer risk in Asian and Pacific Islander American women. *J Natl Cancer Inst*. 2011;103(12):951-61.
390. Gail MH, Costantino JP, Pee D, Bondy M, Newman L, Selvan M, et al. Projecting individualized absolute invasive breast cancer risk in African American women. *J Natl Cancer Inst*. 2007;99(23):1782-92.
391. Gail MH, Brinton LA, Byar DP, Corle DK, Green SB, Schairer C. Projecting individualized probabilities of developing breast cancer for white females who are being examined annually. *J Natl Cancer Inst*. 1989;81.
392. Amir E, Evans DG, Shenton A, Laloo F, Moran A, Boggis C. Evaluation of breast cancer risk assessment packages in the family history evaluation and screening programme. *J Med Genet*. 2003;40.
393. Tice JA, Cummings SR, Smith-Bindman R, Ichikawa L, Barlow WE, Kerlikowske K. Using clinical factors and mammographic breast density to estimate breast cancer risk: development and validation of a new predictive model. *Ann Intern Med*. 2008;148.
394. Meads C, Ahmed I, Riley RD. A systematic review of breast cancer incidence risk prediction models with meta-analysis of their performance. *Breast cancer research and treatment*. 2012;132(2):365-77.

395. Colditz GA, Rosner B. Cumulative risk of breast cancer to age 70 years according to risk factor status: data from the Nurses' Health Study. *Am J Epidemiol*. 2000;152(10):950-64.
396. Rosner B, Colditz GA. Nurses' health study: log-incidence mathematical model of breast cancer incidence. *J Natl Cancer Inst*. 1996;88(6):359-64.
397. Brentnall AR, Harkness EF, Astley SM, Donnelly LS, Stavrinou P, Sampson S, et al. Mammographic density adds accuracy to both the Tyrer-Cuzick and Gail breast cancer risk models in a prospective UK screening cohort. *Breast Cancer Research*. 2015;17(1):147.
398. Burns KEA, Duffett M, Kho ME, Meade MO, Adhikari NKJ, Sinuff T, et al. A guide for the design and conduct of self-administered surveys of clinicians. *Canadian Medical Association Journal*. 2008;179(3):245-52.
399. Boshuizen HC, Viet AL, Picavet HJ, Botterweck A, Van Loon AJM. Non-response in a survey of cardiovascular risk factors in the Dutch population: determinants and resulting biases. *Public Health*. 2006;120.
400. Lund E, Gram IT. Response rate according to title and length of questionnaire. *Scandinavian Journal of Social Medicine*. 1998;26(2):154-60.
401. Blalock SJ, Reyna VF. Using fuzzy-trace theory to understand and improve health judgments, decisions, and behaviors: A literature review. *Health Psychology*. 2016;35(8):781-92.
402. Baker DW, Parker RM, Williams MV, Clark WS, Nurss J. The relationship of patient reading ability to self-reported health and use of health services. *Am J Public Health*. 1997;87(6):1027-30.
403. Baker DW, Williams MV, Parker RM, Gazmararian JA, Nurss J. Development of a brief test to measure functional health literacy. *Patient Educ Couns*. 1999;38(1):33-42.
404. Gazmararian JA, Williams MV, Peel J, Baker DW. Health literacy and knowledge of chronic disease. *Patient Educ Couns*. 2003;51(3):267-75.
405. Wolf MS, Gazmararian JA, Baker DW. Health literacy and functional health status among older adults. *Arch Intern Med*. 2005;165(17):1946-52.
406. Schillinger D, Grumbach K, Piette J, Wang F, Osmond D, Daher C, et al. Association of health literacy with diabetes outcomes. *Jama*. 2002;288(4):475-82.
407. Boynton PM, Greenhalgh T. Selecting, designing, and developing your questionnaire. *BMJ*. 2004;328(7451):1312-5.
408. Allen ES, Christopher J. Likert Scales and Data Analyses. *Quality Progress*. 2007;40(7):64.
409. McColl E, Jacoby A, Thomas L, Soutter J, Bamford C, Steen N, et al. Design and use of questionnaires: a review of best practice applicable to surveys of health service staff and patients. *Health technology assessment (Winchester, England)*. 2001;5(31):1-256.
410. Dormandy E, Hankins M, Marteau TM. Attitudes and uptake of a screening test: The moderating role of ambivalence. *Psychology and Health*. 2006;21(4):499-511.
411. Mindell J, Biddulph JP, Hirani V, Stamatakis E, Craig R, Nunn S, et al. Cohort Profile: The Health Survey for England. *International Journal of Epidemiology*. 2012;41(6):1585-93.
412. Joshi A, Kale S, Chandel S, Pal D. Likert scale: Explored and explained. *British Journal of Applied Science & Technology*. 2015;7(4):396.
413. Jamieson S. Likert scales: how to (ab)use them. *Medical Education*. 2004;38(12):1217-8.
414. Barua A. Methods for decision-making in survey questionnaires based on Likert scale. *Journal of Asian Scientific Research*. 2013;3(1):35-8.

415. Codó E, Dans L, Wei MM. Interviews and questionnaires. *The Blackwell guide to research methods in bilingualism and multilingualism*. 2008:158-76.
416. Bowman-Bowen LC, Menard S. Survey design elements as influences on estimates of self-reported illicit substance use and other illegal activities. *Journal of Drug Issues*. 2016;46(3):178-97.
417. Muehlheusser G, Roider A, Wallmeier N. Gender differences in honesty: Groups versus individuals. *Economics Letters*. 2015;128:25-9.
418. Vannoy SD, Andrews BK, Atkins DC, Dondanville KA, Young-McCaughan S, Peterson AL, et al. Under Reporting of Suicide Ideation in US Army Population Screening: An Ongoing Challenge. *Suicide and Life-Threatening Behavior*. 2017;47(6):723-8.
419. Evans DGR, Warwick J, Astley SM, Stavrinou P, Sahin S, Ingham S. Assessing individual breast cancer risk within the U.K. National Health Service Breast Screening Program: a new paradigm for cancer prevention. *Cancer Prev Res (Phila)*. 2012;5.
420. Cayton H. Patient and public involvement. SAGE Publications Sage UK: London, England; 2004.
421. Stewart D, Wilson R, Selby P, Darbyshire J. Patient and public involvement. *Annals of Oncology*. 2011;22(Suppl_7):vii54-vii6.
422. Haywood K, Lyddiatt A, Brace-McDonnell SJ, Stanisiewska S, Salek S. Establishing the values for patient engagement (PE) in health-related quality of life (HRQoL) research: an international, multiple-stakeholder perspective. *Quality of Life Research*. 2017;26(6):1393-404.
423. INVOLVE. NIHR Involve NIHR2019 [Available from: <https://www.invo.org.uk/>].
424. Haywood KL, Wilson R, Stanisiewska S, Salek S. Using PROMs in Healthcare: Who Should Be in the Driving Seat—Policy Makers, Health Professionals, Methodologists or Patients? *The Patient - Patient-Centered Outcomes Research*. 2016;9(6):495-8.
425. Sopromadze N, Moorosi P. Do we see through their eyes? Testing a bilingual questionnaire in education research using cognitive interviews. *International Journal of Research & Method in Education*. 2017;40(5):524-40.
426. Blair J, Conrad F. Sample Size for Cognitive Interview Pretesting 2011. 636-58 p.
427. Collins D. Pretesting survey instruments: An overview of cognitive methods. *Quality of Life Research*. 2003;12(3):229-38.
428. Gorecki C, Lamping D, Nixon J, Brown J, Cano S. Applying mixed methods to pretest the Pressure Ulcer Quality of Life (PU-QOL) instrument. *Quality of life research*. 2012;21(3):441-51.
429. Willis G. *Analysis of the Cognitive Interview in Questionnaire Design*. 1st ed: Oxford University Press; 2015 April 2015.
430. Hsieh H-F, Shannon SE. Three Approaches to Qualitative Content Analysis. *Qualitative Health Research*. 2005;15(9):1277-88.
431. Levin K, Willis GB, Forsyth BH, Norberg A, Kudela MS, Stark D, et al. Using Cognitive Interviews to Evaluate the Spanish-Language Translation of Dietary Questionnaire. 2009. 2009;3(1):13.
432. Barnette JJ. Effects of Stem and Likert Response Option Reversals on Survey Internal Consistency: If You Feel the Need, There is a Better Alternative to Using those Negatively Worded Stems. *Educational and Psychological Measurement*. 2000;60(3):361-70.
433. Henrica CWdVCB, Terwee; Lidwine, Mokkink; Dirk, Knol;. Development of a measurement instrument. *Measurement in Medicine A Practical Guide*: Cambridge University Press; 2011. p. 30-64.
434. Ware JE, Sherbourne CD. The MOS 36-Item Short-Form Health Survey (SF-36): I. Conceptual Framework and Item Selection. *Medical Care*. 1992;30(6):473-83.

435. Birmingham P, Wilkinson D. Using research instruments: A guide for researchers: Routledge; 2003.
436. Lazarus RS, Smith CA. Knowledge and Appraisal in the Cognition—Emotion Relationship. *Cognition and Emotion*. 1988;2(4):281-300.
437. Willis GB, Artino AR, Jr. What Do Our Respondents Think We're Asking? Using Cognitive Interviewing to Improve Medical Education Surveys. *Journal of graduate medical education*. 2013;5(3):353-6.
438. Adams A, Cox A. Questionnaires, in-depth interviews and focus groups 2008.
439. Henrica CWdVCB, Terwee; Lidwine, Mokkink; Dirk, Knol;. Validity. *Measurement in Medicine A Practical Guide*: Cambridge University Press; 2011. p. 150-201.
440. Berliner JL, Fay AM, Cummings SA, Burnett B, Tillmanns T. NSGC Practice Guideline: Risk Assessment and Genetic Counseling for Hereditary Breast and Ovarian Cancer. *Journal of Genetic Counseling*. 2013;22(2):155-63.
441. Dohoo IR. Bias—Is it a problem, and what should we do? *Preventive Veterinary Medicine*. 2014;113(3):331-7.
442. Whynes DK, Philips Z, Avis M. Why do women participate in the English cervical cancer screening programme? *Journal of Health Economics*. 2007;26(2):306-25.
443. Iglesias C, Torgerson D. Does Length of Questionnaire Matter? A Randomised Trial of Response Rates to a Mailed Questionnaire. *Journal of Health Services Research & Policy*. 2000;5(4):219-21.
444. Giordano L, Giorgi D, Ventura L, Stefanini V, Senore C, Castagno R, et al. Time trends of process and impact indicators in Italian breast screening programmes: 1998-2008. *Epidemiol Prev*. 2010;34(5-6):27-34.
445. Sterne JA, Harbord RM. Funnel plots in meta-analysis. *Stata Journal*. 2004;4:127-41.
446. Sterne JAC, Egger M. Funnel plots for detecting bias in meta-analysis: Guidelines on choice of axis. *Journal of Clinical Epidemiology*. 2001;54(10):1046-55.
447. Orton M, Fitzpatrick R, Fuller A, Mant D, Mlynec C, Thorogood M. Factors affecting women's response to an invitation to attend for a second breast cancer screening examination. *British Journal of General Practice*. 1991;41(349):320-2.
448. Pruitt SL, Shim MJ, Mullen PD, Vernon SW, Amick BC. Association of Area Socioeconomic Status and Breast, Cervical, and Colorectal Cancer Screening: A Systematic Review. *Cancer Epidemiology Biomarkers & Prevention*. 2009;18(10):2579-99.
449. Lundqvist A, Andersson E, Ahlberg I, Nilbert M, Gerdtham U. Socioeconomic inequalities in breast cancer incidence and mortality in Europe—a systematic review and meta-analysis. *The European Journal of Public Health*. 2016;26(5):804-13.



Chapter 8: Appendices

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Breast Cancer Screening (BCS)

BCS is a national screening programme to identify the early detection of breast cancer in women who are apparently healthy. This is not the same as a programme for women known to be at higher risk of BC. In the UK, women aged between 50 and 70 who are registered at a general practice are invited every three years to attend a screening appointment where two x-rays are taken of each breast. The screen is free of charge at the point of care and results are sent to the woman within two weeks.

However, not all screening programmes are identical. In fact, they vary widely globally. Only national organised screening programmes are considered here. Opportunistic programmes include those who opportunistically screen women when they attend healthcare services for reasons other than to receive a mammogram. These types of programmes were not examined in this thesis.

Table 1 shows how different countries have organised their screening programmes.

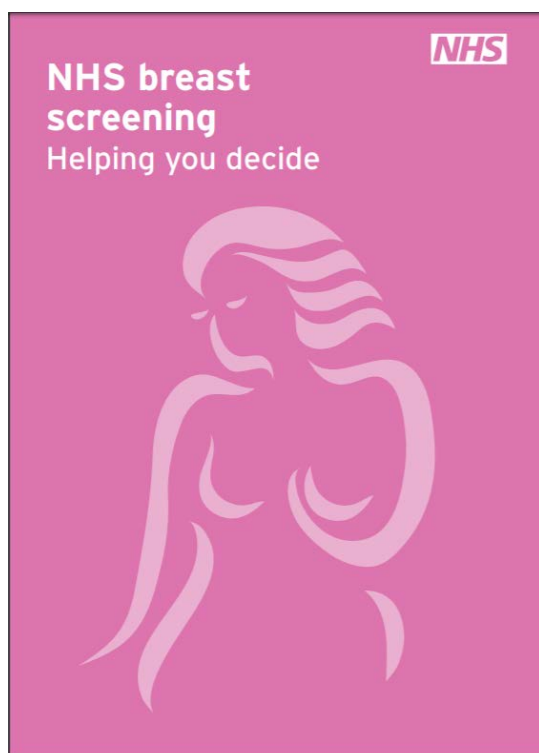
Table 25. Screening programme variation in countries included in this thesis.

NB. USA has an opportunistic screening programme not a national organised screening programme.

Country	Year programme began	Ages screened	Frequency	
			Age 40-49	Age 50+
Australia	1991	40-75+	2 years	2 years
Belgium	1991-2001	50-69	NA	2 years
Canada	1988	40-69	1 year	2 years
Denmark	1991	50-69	NA	2 years
Finland	1987	50-64	NA	2 years
France	1989	50-74	NA	2 years
Germany	2006-7 (full coverage by 2008)	50-69	NA	2 years

Country	Year programme began	Ages screened	Frequency	
Ireland	1998 (2000 in the Eastern Region)	50-64 (extending to 69 years by 2021)	NA	2 years
Israel	1997	50-74	NA	2 years
Italy	2002	50-69	NA	2 years
North Korea	2002-2003	40-69	2 years	2 years
Netherlands	1989	50-74	NA	2 years
Northern Ireland	1988	50-70 years (47-73 years in extension trial)	3 years where appropriate	3 years
Norway	1996	50-69	NA	2 years
Portugal	1990 (1997 in Alentejo region)	45-69	2 years	2 years
Spain	1990 (1995 in Catalonia)	45-69 (50-59 in Catalonia)	2 years (where appropriate)	2 years
Sweden	1986	40-74	18 months	2 years
Switzerland	1999	50-69	NA	2 years
United Kingdom	1988	50-70 years (47-73 years in extension trial)	3 years where appropriate	3 years
United States of America	1995	40-69	1-2 years	1-2 years

For reference, the UK mammography leaflet is displayed below.



It is your choice whether to have breast screening or not. This leaflet aims to help you decide.

Why does the NHS offer breast screening?

The NHS offers screening to save lives from breast cancer. Screening does this by finding breast cancers at an early stage when they are too small to see or feel. Screening does not prevent you from getting breast cancer.

Breast screening does have some risks. Some women who have screening will be diagnosed and treated for breast cancer that would never otherwise have been found, or caused them harm.

Why have I been invited for breast screening?

All women aged 50 to 70 are invited for breast screening every 3 years. Some older and younger women are also being invited as part of a study of screening in different age groups.

If you are over 70, you are still at risk of breast cancer. Although you will no longer automatically get screening invitations after you are 70, you can still have breast screening every three years. You will need to ask your local breast screening unit for an appointment.

What is breast cancer?

Breast cancer starts when cells in the breast begin to grow in an uncontrolled way and build up to form a lump (also known as a tumour). As the cancer grows, cells can spread to other parts of the body and this can be life-threatening.

Breast cancer is the most common type of cancer in the UK. About 12,000 women in the UK die of breast cancer every year. Survival from the disease has been improving over time, and now about 3 out of 4 women diagnosed with breast cancer are alive 10 years later.

Your risk of getting breast cancer goes up as you get older. About 4 out of 5 breast cancers are found in women over 50 years old. Most women with breast cancer **do not** have a family history of the disease.

2

What is breast screening?

Breast screening uses an X-ray test called a mammogram to check the breast for signs of cancer. It can spot cancers that are too small to see or feel.

What will happen if I choose to have breast screening?

When you arrive at the breast screening unit, the staff will check your details and ask you about any breast problems you have had. If you have any questions, please ask.

Mammograms are carried out by women called mammographers. To have a mammogram, you need to undress to the waist. So it may be easier to wear a skirt or trousers instead of a dress.

The mammographer will first explain what will happen. She will then place your breast onto the mammogram machine and lower a plastic plate onto it to flatten it. This helps to keep your breast still and get clear X-rays.

The mammographer will usually take two X-rays of each breast – one from above and one from the side. She will go behind a screen while the X-rays are taken. You have to keep still for several seconds each time.

The whole appointment takes less than half an hour and the mammogram only takes a few minutes.

3



What does having a mammogram feel like?

Having a mammogram can be uncomfortable, and some women find it painful. Usually, any pain passes quickly.

Please phone your breast screening unit before coming for your appointment if:

- **you have a physical disability or find climbing steps difficult**, so that your screening unit can make any necessary arrangements for you;
- **you have breast implants**, you will usually be able to have a mammogram but please let the screening staff know beforehand; or
- **you have had a mammogram recently, or are pregnant or breastfeeding**, as you may be advised to delay breast screening.

5

Breast screening results

You will receive a letter with your breast screening results within 2 weeks of your appointment. The results will also be sent to your GP.

Most women will have a normal result

In about 96 out of every 100 women screened the mammogram will show no sign of cancer – this is a normal result.

Remember that cancer can still develop between mammograms, so tell your GP straight away if you notice any breast changes.

Some women will need more tests because they have an abnormal result

The results letter may say you need more tests because the mammogram looks abnormal. About 4 in every 100 women are asked to come back for more tests after screening.

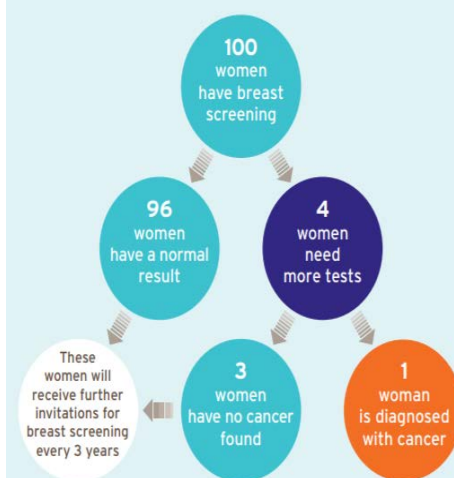
Out of these 4 women, 1 will be found to have cancer. The rest will not have cancer and will go back to having screening invitations every 3 years.

If you are called back for more tests, you may have a breast examination, more mammograms and ultrasound scans. You may also have a biopsy, which is when a small sample is taken from your breast with a needle to be checked under a microscope. You will usually get your results within a week.

Occasionally women will need another mammogram before they get their result

Sometimes technical problems mean that the mammogram is not clear enough to read. If this happens, you will be asked to have another mammogram to get a clearer picture of your breast.

What happens to 100 women each time they have breast screening



7

Making a choice - the possible benefits and risks of breast screening

It is your choice whether or not you have breast screening. There are many different reasons why women decide whether or not to have screening. To help you decide, we've included information on the possible benefits and risks.

Screening saves lives from breast cancer

Lives are saved because cancers are diagnosed and treated earlier than they would have been without screening.

Screening finds breast cancers that would never have caused a woman harm

Some women will be diagnosed and treated for breast cancer that would never otherwise have been found and would not have become life-threatening. This is the main risk of screening.

Doctors cannot always tell whether a breast cancer that is diagnosed will go on to be life-threatening or not, so they offer treatment to all women with breast cancer. This means that some women will be offered treatment that they do not need.

Weighing up the possible benefits and risks of breast screening



There is debate about how many lives are saved by breast screening and how many women are diagnosed with cancers that would never have become life-threatening. The numbers on the next page are the best estimates from a group of experts who have reviewed the evidence.

10

9

If you are found to have breast cancer, it could be either non-invasive or invasive

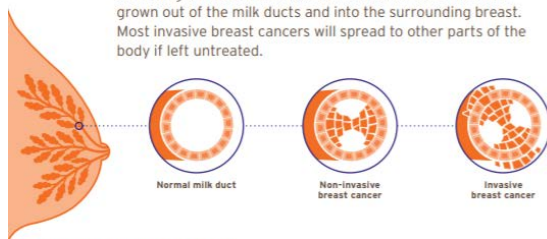
Non-invasive breast cancer

About 1 in 5 women diagnosed with breast cancer through screening will have non-invasive cancer. This means there are cancer cells in the breast, but they are only found inside the milk ducts (tubes) and have not spread any further. This is also called ductal carcinoma in situ (DCIS). In some women, the cancer cells stay inside the ducts. But in others they will grow into (invade) the surrounding breast in the future.

Doctors can't tell whether non-invasive breast cancers will grow into the surrounding breast or not.

Invasive breast cancer

About 4 in 5 women diagnosed with breast cancer through screening will have invasive cancer. This is cancer that has grown out of the milk ducts and into the surrounding breast. Most invasive breast cancers will spread to other parts of the body if left untreated.



Breast cancer treatment

Whether your cancer is invasive or non-invasive, you will be offered treatment and care from a team of breast cancer specialists. The treatment is likely to include surgery (which may mean a mastectomy), hormone therapy, radiotherapy and possibly chemotherapy as well. These treatments can cause serious, long-term side effects.

8

Saving lives from breast cancer

Screening saves about 1 life from breast cancer for every 200 women who are screened. This adds up to about 1,300 lives saved from breast cancer each year in the UK.

Finding cancers that would never have caused a woman harm

About 3 in every 200 women screened every 3 years from the age of 50 to 70 are diagnosed with a cancer that would never have been found without screening and would never have become life-threatening. This adds up to about 4,000 women each year in the UK who are offered treatment they did not need.

Overall, for every 1 woman who has her life saved from breast cancer, about 3 women are diagnosed with a cancer that would never have become life-threatening.

Researchers are trying to find better ways to tell which women have breast cancers that will be life-threatening and which women have cancers that will not.

Can breast screening have other risks?

- Most women who receive an abnormal screening result are found not to have breast cancer. These women experience unnecessary worry and some feel distress which affects their ability to do their normal day-to-day activities at the time.
- X-rays can very rarely cause cancer. Having mammograms every 3 years for 20 years very slightly increases the chance of getting cancer over a woman's lifetime.
- Rarely, breast screening can miss cancers. It picks up most breast cancers, but it misses breast cancer in about 1 in 2,500 women screened.

11

What are the symptoms of breast cancer?

If you get to know how your breasts normally look and feel, you will be more likely to spot any changes that could be signs of breast cancer. This is important even if you have been for breast screening. Look out for the following:

- A lump or thickening in the breast.
- A change in the nipple. The nipple might be pulled back into the breast, or change shape. You might have a rash that makes the nipple look red and scaly, or have blood or another fluid coming from the nipple.
- A change in how the breast feels or looks. It may feel heavy, warm or uneven, or the skin may look dimpled. The size and shape of the breast may change.
- Pain or discomfort in the breast or armpit.
- A swelling or lump in the armpit.

If you have any change to your breast, you should make an appointment to see your GP straight away. You may not have cancer. But if you do, being diagnosed and treated at an early stage may mean that you are more likely to survive breast cancer.

What happens to my mammograms after screening?

The NHS Breast Screening Programme will keep your mammograms for at least 8 years. These are saved securely. The screening programme regularly checks records to make sure the service is as good as possible. Staff in other parts of the health service may need to see your records for this, but your records will only be shared with people who need to see them. If you want to know the results of these regular checks, you can contact your local screening unit.

12

Who can I contact if I have a question?

If you have questions about screening, please contact your local breast screening unit. If you would like to talk to someone about whether to have breast screening, your GP can help. Together, you can weigh up the possible benefits and risks, to help you decide.

You can find more detailed information on breast screening, including the sources of evidence used in writing this leaflet at:

The NHS Breast Screening Programme

cancerscreening.nhs.uk/breastscreen

Informed Choice about Cancer Screening

informedchoiceaboutcancerscreening.org

You may also find the following charity websites provide helpful information about breast screening.

Cancer Research UK - cruk.org

Healthtalkonline - healthtalkonline.org

Breakthrough Breast Cancer - breakthrough.org.uk

Breast Cancer Campaign - breastcancercampaign.org

Breast Cancer Care - breastcancercare.org.uk



13

8.1 Systematic Review

PROSPERO
International prospective register of systematic reviews

NHS
National Institute for
Health Research

A systematic review to identify the worldwide predictors of breast screening uptake
Rebecca Crosby, Sian Williamson, Chris Stinton, Aileen Clarke, Sian Taylor-Phillips

Citation

Rebecca Crosby, Sian Williamson, Chris Stinton, Aileen Clarke, Sian Taylor-Phillips. A systematic review to identify the worldwide predictors of breast screening uptake. PROSPERO 2016 CRD42016051597 Available from: http://www.crd.york.ac.uk/PROSPERO/display_record.php?ID=CRD42016051597

Review question

What are the predictors of breast cancer screening uptake worldwide?

Searches

The electronic databases that will be searched to identify published studies are: EMBASE (via Ovid), MEDLINE (via Ovid), CINAHL (The Cumulative Index to Nursing and Allied Health Literature), PsycINFO, Cochrane Library (Wiley) including the Cochrane Database of Systematic Reviews and Thomson Reuters Web of Science (all databases including Science Citation Index, Conference Proceedings and Science Citation Index Expanded and Social Sciences Index). Reference lists of included papers and relevant reviews will be searched for papers that were not identified by the electronic search. Experts in the field will be contacted to identify further significant papers.

Types of study to be included

Included: Any quantitative study type that mentions uptake rates of breast screening; Study must include at least one predictor of uptake to be included. Excluded: Case studies, editorials, letters and commentaries.

Condition or domain being studied

Breast screening. Predictors of uptake.

Participants/population

Inclusion:

Women of screening age (variable worldwide).

Exclusion:

Women with previously diagnosed breast cancer;

Women attending diagnostic screening;

Non-human studies.

Intervention(s), exposure(s)

Any intervention related to uptake of breast screening will be included in the review. Studies will be included where they mention uptake rates of breast screening - either current, previous or changes. The study must mention at least one predictor variable of uptake.

Comparator(s)/control

Not applicable.

Context

Any country with a breast screening programme will be included.

Articles written since 1987 will be included as this was when the first breast screening programme was introduced globally.

Main outcome(s)

Worldwide predictors of uptake of breast screening.

Timing and effect measures

The outcomes will be measured in terms of uptake, i.e. rate or percentages.

Additional outcome(s)

None.

Timing and effect measures

Not applicable.

Data extraction (selection and coding)

A two-step process will be used to identify relevant studies at abstract and title stage and then at full text stage using pre-defined screening criteria. Two researchers will screening the titles and abstracts against inclusion and inclusion criteria independently using the results from the search. if a decision cannot be made on the title and abstract a full text review will be performed.

Where there are disagreements between the two researchers, a third reviewer will be contacted until a consensus is reached.

The full texts of the included studies will be obtained and undergo a second screen by two researchers and again any discrepancies resolved by the third reviewer.

Reasons for inclusion and exclusion will be stated where appropriate. The PRISMA flow diagram will be provided in the review.

Data extraction will take place after the full text review and will include:

General - authors, year, publication journal, study title, article type, stated aims, period of study;

Study characteristics - country, setting, screening programme style in this country;

Study design - cohort, case-control, prospective, retrospective, randomised controlled trial, etc.;

Participants - population;

Outcomes - primary and secondary outcomes definitions, validity of measures used, data collection method;

Predictors - number of predictors, type of predictors, definition of predictors;

overall results;

Overview - strengths and limitations of the study, Was the study blinded?; source(s) of research funding, potential conflicts of interest.

The domains involved in data extraction are broad and comprehensive due to the variability of the potential studies to be included within this review. A piloted data extraction form will be used by the two researchers to test. Any discrepancies will be discussed and a third reviewer will be involved where necessary to reach a consensus.

Risk of bias (quality) assessment

Extracted data will be stored in tabular format on Microsoft Access spreadsheet to complete the methodological quality assessment/risk of bias scoring.

Quality assessment of the included studies will be completed using the quality assessment tool.

Strategy for data synthesis

Descriptive analysis will be presented in tabular format to describe the included studies. Significant heterogeneity is expected to be found amongst the included papers considering the differences between screening programmes internationally. Therefore pooling data in a meta-regression would not be appropriate. Instead, a narrative synthesis will be adopted to explain and summarise results by predictor. This narrative synthesis will analyse the population characteristics, predictor variables and their effects on uptake rate.

Analysis of subgroups or subsets

None planned.

Contact details for further information

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Organisational affiliation of the review

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Review team members and their organisational affiliations

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Miss Sian Williamson. University of Warwick

PROSPERO
International prospective register of systematic reviews



Dr Chris Stinton. University of Warwick
Professor Aileen Clarke. University of Warwick
Dr Sian Taylor-Phillips. University of Warwick

Anticipated or actual start date
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Conflicts of interest
None known

Language
English

Country
England

Stage of review
Review_Ongoing

Subject index terms status
Subject indexing assigned by CRD

Subject index terms
Breast Neoplasms; Developed Countries; Developing Countries; Early Detection of Cancer; Early Diagnosis; Healthcare Disparities; Humans; Mass Screening; Patient Acceptance of Health Care; Socioeconomic Factors

Date of registration in PROSPERO
17 November 2016

Date of publication of this version
23 June 2017

Revision note for this version
Updated the prospero registration to be more accurate. Updated inclusion criteria to only include quantitative studies due to the number of results found after sifting.

Details of any existing review of the same topic by the same authors

Stage of review at time of this submission

8.1.1 Eligibility criteria

Inclusion criteria

Women routinely invited for mammography screening for breast cancer

Age variable but relevant for each country screening programme – 90% sample have to be within age range for that national programme

The study must mention attendance at the organised screening programme – either current, previous or changes

Study must mention at least one predictor variable of uptake

Uptake of mammography has to be reported and separately to CBE/BSE

Actual attendance for BCS

Quantitative study designs, reporting numerical data

Any country (with a breast cancer screening programme)

Articles written since 1987

Written in English

Humans

Exclusion criteria

Case-studies, editorials, letters, commentary, conference abstracts, structured abstracts

Protocols, ongoing studies

Qualitative papers

Systematic reviews and meta-analyses (reference lists will be searched for relevant papers)

Symptomatic cases of breast cancer screening

Opportunistic screening

Diagnostic screening

Predictors not mentioned

Uptake not mentioned

Self-report attendance at mammography/uptake of breast screening (if supported by medical records, paper must be included)

Uptake data must be present for individual predictors

Subsets/selective samples of the eligible population (ie. sample of non-attenders or attenders only, or only specific groups)

Non-human studies

Articles written before 1987

Not written in English

Intention to attend

8.1.2 Search strategies for database searching

Search strategies

The following search strategies (shown in the figures below) were applied to each of the six databases searched for this review.

Results: 4,051
(from Web of Science Core Collection)

You searched for: TOPIC: (breast*)
AND TOPIC: ((screen* OR "early detection" OR mammogra* OR "mass screening" OR "screening program*" OR "mammogra* screen*" OR "direct to consumer" OR "health screen*"))
AND TOPIC: ((uptake OR adheren* OR complian* OR "patient acceptance of healthcare" OR "patient acceptance" OR "patient access" OR attend*))

Refined by: PUBLICATION YEARS: (2015 OR 2008 OR 1999 OR 1994 OR 2013 OR 2006 OR 2002 OR 1992 OR 2014 OR 2007 OR 1998 OR 1993 OR 2011 OR 2005 OR 1997 OR 1991 OR 2016 OR 2003 OR 2000 OR 1990 OR 2012 OR 2004 OR 1996 OR 1989 OR 2010 OR 2001 OR 1995 OR 1988 OR 2009) AND LANGUAGES: (ENGLISH) AND LANGUAGES: (ENGLISH) AND LANGUAGES: (ENGLISH)

Timespan: 1987-2016. **Indexes:** SCI-EXPANDED, SSCI, CPCI-S, CPCI-SSH, ESCI.

[...Less](#)

Figure 62 Search strategy for Web of Science. Conducted on 05.12.16.

#	Searches	Results
1	breast*.mp. or exp breast/	425102
2	(screen* or "early detection" or mammogra* or "mass screening" or "screening program*" or "mammogra* screen*" or "direct to consumer" or "health screen*").mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]	680843
3	(uptake or adheren* or complian* or "patient acceptance of healthcare" or "patient acceptance" or "patient access" or attend*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]	746602
4	1 and 2 and 3	5108
5	limit 4 to humans	5074
6	limit 5 to english language	4818
7	limit 6 to yr="1987-Current"	4707

Figure 63. Search strategy for Medline OVID. Conducted on 28.11.16

There are 1075 results from 9640 records for your search on 'breast' and screen* OR "early detection" OR mammogra* OR "mass screening" OR "screening program*" OR "mammogra* screen*" OR "direct to consumer" OR "health screen*" and uptake OR adheren* OR complian* OR "patient acceptance of healthcare" OR "patient acceptance" OR "patient access" OR attend* , Publication Year from 1987 to 2016 in Cochrane Reviews'

Figure 64. Search strategy for PsycINFO. Conducted on 05.12.16.

breast* AND (screen* OR "early detection" OR mammogra* OR "mass screening" OR "screening program*" OR "mammogra* screen*" OR "direct to consumer" OR "health screen*") AND (uptake OR adheren* OR complian* OR "patient acceptance of healthcare" OR "patient acceptance" OR attend*)

Figure 65. Search strategy for CINAHL. Conducted on 28.11.16

S5	S1 AND S2 AND S3	Limiters - Published Date: 19870101-20181231; English Language; Human	View Results (1,237) View Details Edit
S4	S1 AND S2 AND S3	Restrict by Language - english	View Results (2,413) View Details Edit
S3	TX uptake OR TX adherence OR TX compliance OR TX patient acceptance of health care OR TX patient acceptance OR TX patient access OR TX health screen	Search modes - Find all my search terms	View Results (104,614) View Details Edit
S2	TX screen OR TX early detection OR TX mammogram OR TX mass screening OR TX screening program OR TX mammogram screen OR TX direct to consumer OR TX health screen	Search modes - Boolean/Phrase	View Results (102,730) View Details Edit
S1	TX breast	Search modes - Boolean/Phrase	View Results (85,385) View Details Edit

Figure 66. Search strategy for Cochrane Library. Conducted on 05.12.16.

S5	S1 AND S2 AND S3	Limiters - Published Date: 19870101-20181231; English Language; Human	View Results (1,237) View Details Edit
S4	S1 AND S2 AND S3	Restrict by Language - english	View Results (2,413) View Details Edit
S3	TX uptake OR TX adherence OR TX compliance OR TX patient acceptance of health care OR TX patient acceptance OR TX patient access OR TX health screen	Search modes - Find all my search terms	View Results (104,614) View Details Edit
S2	TX screen OR TX early detection OR TX mammogram OR TX mass screening OR TX screening program OR TX mammogram screen OR TX direct to consumer OR TX health screen	Search modes - Boolean/Phrase	View Results (102,730) View Details Edit
S1	TX breast	Search modes - Boolean/Phrase	View Results (85,385) View Details Edit

Figure 67. Search strategy for Embase. Conducted on 28.11.16.

8.1.3 Constructs of the Venn diagram

Table 27 below shows the different individual predictors that comprise the overarching constructs used to create the Venn diagram and summary of predictors in the systematic review as shown in *Table 7* in the main body of the thesis.

Table 26. Constructs of the Venn diagram

Demographics	Healthcare system	Health status or medication	Interventions
Age	Insurance	False positive	Invitations
Socioeconomic status	Distance to screening centre	Smoking status	Tailored or personalised interventions
Education	Fixed or mobile screening site	Number of chronic conditions	Reminder systems
Ethnicity	GP related factors	Number of primary care visits	Incentive
Nationality	(sex, attitude, years since graduation)	last year	
Religion	Invite type	Prior screening behaviour	
Language spoken	Usual care or not	Previous attendance	
Marital status		behaviour	
Income		Family history of breast cancer	
Body mass index		Victim of abuse	
Immigration status		status	
Number of children			
Housing			
Car access			
Location of housing			
Time			
Caregiving status			
Social support			
Knowledge			
Intentions to attend			
Opinions			

8.1.4 Study Characteristics

The following characteristics were extracted from papers using the following data extraction sheet.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
Author	Year (published)	Country	Study Dates	Study Design (cohort, case-control, perspective, retrospective, RCT, secondary, etc)	Range age participants	Number of participants for study (where possible)		Predictor type (single) Paper can appear in multiple tabs	Was measurement of predictor validated	Comments	Predictor specific	Total attended in category (e.g. all age attenders)	Actual number of who attended A	Uptake % attended	Total not attended in category (e.g. all age non-attenders)	Actual number of who did not attend B	Uptake % not attended	Odds Ratios <u>EXTRACTED</u> (attending [vs not attending]) unadjusted	Where did I find this data? Page and table numbers in article	Comments
Study Characteristics											Outcome (uptake)	A		B		AD/BC				
Aarts	2011	Netherlands	1998 to 2005	Retrospective	C 50 to 75	1067952		Age	NA		<50 50-54 55-59 60-64 65-69 70-75 >75	901555 901555 901555 901555 901555 901555 901555	67768 190490 207443 169409 147179 108970 10296	8 21 23 19 16 12 1	166397 166397 166397 166397 166397 166397 166397	12586 34097 34533 27779 25886 27247 4269	8 20 21 17 16 16 3		Page 520 Table 1	total attenders = 901555 total non attenders =
Aarts	2011	Netherlands	1998 to 2005	Retrospective	C 50 to 75	1067952		SES	NA		Low Medium High	901555 901555 901555	201396 381152 319007	22 42 35	166397 166397 166397	54008 65015 47374	32 39 48		Page 520 Table 1	total attenders = 901555 total non attenders =
Aro	1999	Finland	1992 to 1993	Cohort	NA	1458		marital status education			married non-married high	871 871 898	671 200 253	77 23 29	588 588 640	382 206 223	65 35 38		page 84, table 1, number 3	
◀ ▶		Demographics		History Disease		Medication INCL smoking			Psychosocial		Multiple predictors (list only)			Intervention studies			Other		Quality Assessment	

Figure 68. Data extraction sheet

Table 27: Studies included in the systematic review.

SES=socioeconomic status, BMI=body mass index, HRT=hormone replacement therapy, BC=breast cancer.

****= data looks at percentages/behaviours of those included in the study so data sums to 100%. E.g. Of the 50 participants, 80% were married who attended.**

†= data includes “rescreening” data that although meets the review criteria, must be analysed separately.

Author	Year	Study Design	Study Dates	Geographic area	Number of participants	Predictors Investigated	Summary of main findings as reported in the paper	Ref.
Aarts**	2011	Retrospective Cohort	1998 to 2005	Netherlands	1067952	Age SES Year	↓with increasing age ↑non-uptake with high SES ↑over time (1998-2005)	(79)
Andersen**	2008	Retrospective Cohort	1991 to 2003	Denmark	-	False positive result	↔remained stable over time (1991-2001) ↔no difference to negative test result women	(262)
Aro**	1999	Cohort	1992 to 1993	Finland	1458	Smoking Serious illness Marital Status Education Income Perceived BC risk Expectation of pain Breast self-examination	↑ non-smokers ↓uptake with serious illness ↑attendance if married ↔ no apparent trend ↑non-uptake in low income ↑moderate perceived risk ↑in no expectation of	(125)

Author	Year	Study Design	Study Dates	Geographic area	Number of participants	Predictors Investigated	Summary of main findings as reported in the paper	Ref.
							pain ↑ uptake and non-uptake in occasional BSE group	
Banks**	2002	Cohort	1998	United Kingdom	1064	Age SES	↔ no apparent trend ↑ uptake in affluent (high SES)	(133)
Bansal	2012	Retrospective Cohort	2002 to 2008	United Kingdom	139374	Ethnicity	↓ uptake in Pakistani, African, Indian and south Asian women	(248)
Beaber**	2016	Cohort	January 2011 to September 2013	United States of America	3413	Ethnicity BMI Insurance SES Primary care visits	↓ in non-hispanic other ↑ highest in <25 (normal) ↑ commercial/private ↑ non-uptake in low income ↑ more healthcare contact	(263)
Berens	2014	Retrospective Cohort	2010 to 2011 inclusive	Germany	18658	Immigration status Age	Turkish migrants to Germany have ↑ uptake than non-migrants ↓ in older women	(264)

Author	Year	Study Design	Study Dates	Geographic area	Number of participants	Predictors Investigated	Summary of main findings as reported in the paper	Ref.
Blanchard†	2004	Retrospective Cohort	Jan 1985 to Feb 2002	United States of America	83511	Previous negative biopsy Ethnicity Insurance	↑re-screening ↑White, ↓hispanic ↑at preferred provider organisation, ↓medicaid	(55)
Bourmaud	2016	Randomised Controlled Trial	May and June 2009	France	15844	Decision aid vs standard information	↑uptake in standard information, ↑non-uptake in decision aid	(265)
Bulliard	2004	Retrospective Cohort	October 1993 to January 1999	Switzerland	4162	Age Nationality Distance to screening centre Marital status SES Education Smoking status BMI Prior mammography use	↓with increasing age ↑Swiss nationals ↓with increasing distance ↑married women, lowest in divorced/separated ↑uptake intermediate SES ↑uptake middle education ↑non-smoker ↑in 'normal' range (21-25)	(266)

Author	Year	Study Design	Study Dates	Geographic area	Number of participants	Predictors Investigated	Summary of main findings as reported in the paper	Ref.
						Outcome previous test	↑ if used <2 years before ↑ previous negative result	
Carney	2005	Retrospective Cohort	May 1996 to December 2000	United States of America	-	Age (14month interval) Age (15-26 interval)	↑ highest in 60-69yrs group ↑ highest in 40-49yrs group	(267)
Chiarelli†	2003	Retrospective Cohort	July 1990 to December 1995	Canada	140723	Age	↑ in younger women	(249)
Chouliara**	2002	Case Control	-	United Kingdom	58	Age Education Marital status Number children Family history BC	↑ in older women ↑ with basic education ↑ married women ↑ 2 children (inverse u-shape) ↑ in those with no family history	(158)
Coyle***†	2014	Retrospective Cohort	April 2001 to October 2004	Northern Ireland	11931	Consistent Age Marital status	↑ with age ↑ married	(114)

Author	Year	Study Design	Study Dates	Geographic area	Number of participants	Predictors Investigated	Summary of main findings as reported in the paper	Ref.
						Housing tenure Car access Education Social class Limiting long-term illness One-time attender Age Marital status Housing tenure Car access Education Social class Limiting long-term illness	↑owned house ↑with increasing access ↑no education ↑routine ↑if no long-limiting illness ↑with age ↑married ↑owned house ↑with increasing access ↑no education ↑routine ↑if no long-limiting illness	
Euler-Chelpin†	2008	Retrospective Cohort	April 1991 to March 1999 and November 1993 to	Denmark	73415	Social class Always attender Attend all but one	Copenhagen and Funen ↑ secretarial ↔ no general trend ↑ with lower primary/unknown SES	(167)

Author	Year	Study Design	Study Dates	Geographic area	Number of participants	Predictors Investigated	Summary of main findings as reported in the paper	Ref.
			December 2001			Sometimes attender Never attender	'u'-shape trend association with SES	
Ferrante	2006	Audit	August 2000 to March 2003	United States of America	1809	Age Ethnicity Marital status Education Insurance Smoking status Family history BC Number primary care visits Obesity	↑with age ↑hispanics>other>White ↓single ↑high school or less ↓commercial and medicaid ↑ non-smoker ↑with family history ↑with more visits ↑non-obese (very close)	(268)
Fitzpatrick†	2011	Retrospective Cohort	2000 to 2007	Ireland	-	False positive no tissue sampling core biopsy open surgical biopsy	Rescreening highest in: ↑age 55-59 ↑age 50-54 ↑age 60-62 ↑age 50-54	(269)

Author	Year	Study Design	Study Dates	Geographic area	Number of participants	Predictors Investigated	Summary of main findings as reported in the paper	Ref.
						TOTAL (all false pos)		
Fleming**	2013	Cohort	2006-10	Ireland	2500	First PNA Age Insurance Education Area of residence Family history BC Subsequent PNA Psychosocial Mammogram is painful Mammogram is embarrassing Friends/family had positive experience	↓ in older women ↑ with insurance ↓ with education ↑ in rural areas ↓ all reduced uptake Shows same data trends as First PNA ↑ in women who do not attend (31.8% v 31.7%) ↑ in women who attend ↑ in women who attend	(168)

Author	Year	Study Design	Study Dates	Geographic area	Number of participants	Predictors Investigated	Summary of main findings as reported in the paper	Ref.
Freitas**	2011	Cross-sectional	October 2008 to May 2009	Portugal	13948	Age Marital status Residence Education level Employment status Education Knowledge - general Knowledge – frequency Time since last mammogram Healthcare access frequency Use of own car	↑ in younger and older women ↑ in never married, divorced, widowed women ↑ in urban residence ↑ in secondary level ↑ in not employed women ↑ with more education ↓ with good knowledge ↑ if correct frequency known ↑ within recommended ↑ if more than 4 times ↑ with car access	(121)

Author	Year	Study Design	Study Dates	Geographic area	Number of participants	Predictors Investigated	Summary of main findings as reported in the paper	Ref.
Gandhi	2010	Chart Audit	July 2004 to June 2005	United States of America	382	Intimate partner violence – emotional – physical and/or sexual	Those with emotional abuse were likely to attend screening. Those with physical and/or sexual were less likely to attend, only 15.4% attended.	(270)
Gatrell	1998	Retrospective Cohort	1989 to 1995	United Kingdom	24000	Year (round 1 and 2)	82.9% attended Round 1 83.9% attended Round 2	(271)
Giordano	2008	Retrospective Cohort	1996 to 2005 (2009)	Italy	-	Age Time First attendances Subsequent attendances Age (1999) Age (2009)	↑ over time for those aged 55-59, 60-64, 65-69, total. ↓ for 50-54 yrs ↑ 60.6% (2000), 61.9% (2008) ↔ First attendance ↑ from 3.6% to 4.2% ↓ with age ↑ with age	(7, 272, 444) Three articles used the same data

Author	Year	Study Design	Study Dates	Geographic area	Number of participants	Predictors Investigated	Summary of main findings as reported in the paper	Ref.
Giorgi	2000	Randomised Controlled Trial	April 1994 to December 1996	Italy	-	Letter signed by GP Reminder letter from GP Reminder letter from screening centre	↑↑↑ ↑↑ ↑ Indicate effectiveness of interventions on screening uptake in each location	(273)
Gregory-Mercado†	2007	Retrospective Cohort	2000 to 2004	United States of America	-	Age Ethnicity	↑rescreening with age ↑re-uptake with American Indian, Alaska natives and White women	(274)
Hurley	1994	Randomised controlled trial	NA	Australia	2266	Letter A (appointment) Letter B (no appointment)	↑attendance first invite Majority did not attend	(275)
Hyndman	2000	Retrospective Cohort	1991 to 1996	Australia	104876	SES Distance	↓attendance in high SES ↓with distance to centre	(276)
Jean**	2005	Retrospective Cohort	May 1998 to June 2000	Canada	684028	Mailing letters intervention	↓older women ↑after intervention	(277)

Author	Year	Study Design	Study Dates	Geographic area	Number of participants	Predictors Investigated	Summary of main findings as reported in the paper	Ref.
Jensen** (A)	2012	Retrospective Cohort	February 2008 to December 2009	Denmark	149234	Age Ethnicity Marital status Occupation Education Income Access to vehicle Residential ownership Kilometres to screening site Chronic disease	↓with age ↑majority attended natives ↑married ↑employed ↑11 to 15 yrs education ↑with wealth ↑car access ↑house ownership ↓with distance ↓with illness	(278, 326) Two articles used same data
Jensen** (B)	2012	Retrospective Cohort	February 2009 to October 2009	Denmark	13288	GP attitude (to BCS) GP gender Age Income Marital status Ethnicity Distance to screening site	↑positive attitude ↑male GP ↓with age ↑with wealth ↑married ↑Danish natives ↓distance to screening site	(279)

Author	Year	Study Design	Study Dates	Geographic area	Number of participants	Predictors Investigated	Summary of main findings as reported in the paper	Ref.
Jensen (A)	2015	Retrospective Cohort	2008 to 2009	Denmark	4512	Age Marital status Education Diagnosed chronic diseases	↓ with age ↑ married ↑ 11 to 15 yrs education ↓ with number illnesses, except 3+chronic = ↑ BCS	(144)
Jensen (B)	2015	Retrospective Cohort	2008 to 2009	Denmark	4512	Frequency of contacts Instrumental support Emotional support	↑ attendance ↑ attendance ↑ attendance	(280)

Kee	1993	Cross-sectional	1991	Northern Ireland	600	Opinions: BCS does more good than harm BCS helps live longer BCS means fewer mastectomies needed BCS means better chance of a cure if have BC BCS prevents BC BCS does more harm than good	Uptake % 91.3% 76.3% 79.3% 89.7% 44.3% 3%	(281)
Kinnear	2010	Retrospective Cohort	2001 to 2004	Northern Ireland	37211	Caregiving status	↑ in carers 1-19hrs/week	(282)
Kinnear	2011	Retrospective Cohort	2001 to 2004	Northern Ireland	-	Age Marital status Housing tenure Social class	↑ 50-54 yrs ↑ married women ↑ owner ↑ higher SES	(283)
Lagerlund	2015	Retrospective Cohort	2005 to 2009	Sweden	29915	Year	↓ over time	(285)

Lagerlund	2002	Retrospective Cohort	February 1988 to June 1987	Sweden	46041	Age Children Cohabitation Education SES Income Home ownership Country of origin	↓with age ↑highest with 2 births ↑cohabitation ↑education, highly educated ↓ ↔Lowest in unemployed ↔ ↑home ownership ↑natives	(75)
Leung	2015	Retrospective Cohort	2008 to 2010	United Kingdom	27416	Area of residence	75% attended in Scotland. More in rural than urban.	(286)
Lim	2010	Retrospective Cohort	2004 to 2008	Korea	Variable	Year Age Insurance status Area of residence	↑with time ↓with age ↓medicaid ↓provincial areas	(284)
Liu	2014	Chart Review	October 2008 to August 2009	United States of America	1859	Chronic Conditions	↑with chronic condition ↔ across number of chronic conditions	(250)

Makedonov**	2015	Case-control	December 2005 to June 2011	Canada	105665	Physician sex	↑with male physician	(287)
Matson	2001	Retrospective Cohort	Jan 1990 to December 1994	Sweden	32605	SES	↑in higher SES women	(288)
Maxwell**	2013	Retrospective Cohort	April 2005 to March 2008	United Kingdom	253017	False positive	↓reattendance if open biopsy rather than needle sampling or no tissue	(143)
May	1999	Retrospective Cohort	January to June 1995	United States of America	1111	Age Ethnicity Clinic type Insurance Number clinic visits per year In long-term care Ambulatory Pap smears in past 3 years	↓with age ↑black ↔ ↓uninsured ↑with more visits ↓if needing long-term care ↑if ambulatory ↑if had pap smear	(289)

						History of breast biopsy	↑history of breast biopsy	
Mayer	1998	Randomised Controlled Trial	December 1991 to March 1992	United States of America	-	Reminder letter type	↑uptake with those receiving the physician endorsed letter	(290)
McCann†	2002	Retrospective Cohort	1989-1991	United Kingdom	140387	False positive	↓reattendance if assessed benign rather than assessed normal	(291)
McCarthy	1996	Retrospective Cohort	1991-1992	United States of America	8805	Number of healthcare visits Mammography on-site Visit to gynaecologist Ethnicity Marital status Income Age	↑healthcare visits in those with 2-10 per year ↑uptake if on-site ↑if visited gynaecologist ↑Caucasians ↑married ↑with wealth ↔	(292)
Meguerditchian**	2012	Retrospective Cohort	July 1992 to	Canada	96708	Hospitalisation in past year	↓uptake	(293)

			February 1993			Breast biopsy in past year Mammogram in last year Physician sex	↑↑↑ if yes ↑ if no (due) ↑ female	
Meldrum	1994	Randomised Controlled Trial	July 1992 to February 1993	United Kingdom	3083	Standard letter type Tailored letter type	Both letter types had best uptake in those with previous false positive. 62% in tailored letter vs 60%	(294)
Moss†	2001	Retrospective Cohort	May 1996-	United Kingdom	260914	Age Previous screening history	↑ in younger ↑↑ in those with recent screen (<=5 years)	(295)
Norum	2012	Retrospective Cohort	2001 to 2010	Norway	20480	Sami group/Age Non-sami group/Age	↑ in 60-69 yrs ↑ in 50-59 yrs	(296)
O'Byrne†	2000	Retrospective Cohort	January 1995 to December 1996	Australia	119502	Indigenous status Language spoken at home Location HRT	↑ non-indigenous ↑ N European ↑ Remote location	(141)

						Family history BC Clinic type	↑ in recipients of HRT ↔ no difference ↑ mobile clinics	
Offman†	2013	Randomised controlled Trial	June 2010 to July 2011	United Kingdom	19362	Invite Type Screening unit Previous attendance Age	↑out of office hours option ↔variable ↑attenders ↔variable	(297)
Oh†	2011	Retrospective Cohort	2005 to 2008	Korea	2511976	Age Insurance Screening results at baseline History of mammogram screening Year	↑ for middle age groups ↑ national health insurance ↑ if negative ↑ if previously screened ↑ in 2006 than 2005	(298)
Ore	1997	Randomised controlled trial/Interview	March to April 1994	Israel	1500	Age Ethnic origin	↑ in 65-69 yrs ↑ in asian/african women	(299)

						Education Marital status Religiosity Working outside the home SES Regular gynaecological check up Visiting physician in the last year	↑ in those with 10 to 14 yrs ↑ in married ↑ without religion ↑ working outside home ↑ in high SES ↑ yes ↑ yes	
O'Reilly	2012 & 2013	Retrospective Cohort	2001 to 2004	Northern Ireland	37211	Age Marital status SES Car access Housing tenure Education Limiting long term illness Residence Religion	↑ in 50-54 yrs ↑ married ↑ high SES ↑ 2+ cars ↑ house owner ↑ educated to GCSE ↑ good health ↑ rural ↑ in protestant	(300, 331) Two articles using same data

Otten	1996	Retrospective Cohort	1975 to 1992	Netherlands	41087	Age Year	↑ younger ↓ time (rounds)	(301)
Page	2005	Randomised Controlled Trial	March 2004	Australia	3175	Invite type	↑ reminder letter at 6 weeks	(302)
Peeters	1989	Retrospective Cohort	1975 to 1987	Netherlands	Variable	Age Year	↑ younger women ↓ time (rounds)	(303)
Peeters	1994	Randomised Controlled Trial	March to July 1992	Netherlands	3726	Age	↑ younger women	(304)
Pelfrene	1998	Retrospective Cohort	1992 to 1994	Belgium	41585	Age Nationality	↑ 50-59 yrs ↑ Belgium born	(305)
Pinckney†	2003	Retrospective Cohort	May 1996 to May 1997	United States of America	48538	False positive	↑ in women aged 50+ for both true negative (at 30 months) and false positive	(251)
Renshaw	2010	Retrospective Cohort	April 2004 to March 2007	United Kingdom	825159	Age SES Invitation type	↑ younger ↑ affluent ↑ highest in routine recall	(135)

Rodriguez	1995	Retrospective Cohort	December 1988 to May 1989	Spain	1859	Knowledge Attitudes Practices Age Family history BC Education	Of those who attended, the majority were knowledgeable and had relevant attitudes towards screening and partake in other health-care practices ↑ in younger women FHx had a variable impact ↑ in less educated	(306)
Rutten	2014	Retrospective Cohort	2004 to 2013	USA	31377	Guideline changes Age	↓ after changes ↑ in 50-74 yr olds	(307)
Rutter	1997	Cohort	1996	United Kingdom	2239	Age Education SES Marital status Recent health Long-standing illness	↑ younger women ↑ no qualifications ↑ lower education ↑ married ↑ good health	(308)

						Previous smear Previous mammogram Previous breast examination	↑ no long-standing illness ↑ previous smear ↑ previous mammogram ↑ if previous breast exam	
Scaf-Klomp	1995	Cohort	1975 to 1990	Netherlands	6898	Age	↑ younger women	(116)
Seeley	1994	Cohort	October 1992 to January 1993	United Kingdom	-	Age HRT	↑ in younger ↑ HRT recipients	(309)
Segnan	1998	Randomised Controlled Trial	March 1993 to December 1993	Italy	8069	Invite type	Majority attend at first invite, only small amount attend following postal reminder	(310)
Shippee	2012	Retrospective Cohort	January 2005 to	United States of America	940	Location	88.77% uptake	(311)

			December 2009					
Simon	2001	Randomised Controlled Trial	October 1992 to September 1992	United States of America	1966	Location Intervention letter	No apparent difference ↑ in direct access letter (n.s.)	(312)
St-Jacques	2013	Retrospective Cohort	October 2006 to October 2008	Canada	985431	Distance to screening centre Age SES	↑ in 12.5 to <25km ↓ older women ↓ affluent women	(313)
Szczepura	2008	Retrospective Cohort	1989 to 2004	United Kingdom	211512	Same for all rounds Age SES Ethnicity	↑ in younger ↑ affluent ↑ non-asian	(140)
Taplin	1994	Randomised Controlled Trial	-	United States of America	1500	Invite type	Combined intervention of primary physician invite + reminder postcard had best uptake (61.7%)	(314)
Tatla†	2003	Retrospective Cohort	January 1995 to	Canada	57902	Location SES	↑ rural ↑ in less affluent	(255)

			December 2000			Age Language Initial mammography results Previous mammography history Referral by health professional	↑ younger women ↑ English ↑ normal previous results ↑ previous attendee ↑ referred by health professional	
Taylor	1999	Randomised Controlled Trial	September 1995 to November 1996	United States of America	314	Age Race Insurance previous mammography Intervention/Control group	↑younger women ↓White women ↑commercial ↑previous screened ↑intervention group	(315)
Taylor-Phillips	2013	Observational before/after study	October 2012 to November 2012	United Kingdom	12023	Age Deprivation Previous attendance	↑older women ↑affluent women ↑previous attender	(166)
Tornberg	2005	Retrospective Cohort	1989 to 1999	Sweden	-	Invite number Attendance at		(316)

						subsequent rounds following non-attendance	Variable uptake rates if women did not attend first screening invite	
Ulcickas†	1999	Retrospective Cohort	1989 to 1996	United States of America	-	Race Age Marital status Income Timing of index mammogram	Rescreening ↑ Caucasian ↓ older women ↑ married women ↑ with higher income ↑ if 1992-1994 index	(169)
Vaile	1993	Cohort	-	United Kingdom	2060	Location Age Education Social class Marital status Recent health Previous smear Previous mammogram	↑ rural ↑ younger women ↑ less educated ↑ working class ↑ married women ↑ good health ↑ previous smear ↑ no previous mammogram	(171)

Valanis	2003	Retrospective Cohort	1997 to 1999	United States of America	-	Age Intervention (inreach, outreach or combined)	↔ no trend ↑ outreach	(317)
Vermeer	2010	Retrospective Cohort	1997 to 2008	Netherlands	1279982	Nationality Time	↑ in Dutch women ↑ 2007-2008	(252)
Vidal	2014	Cohort	June 2011 to July 2011	Spain	12786	Location Text reminder Previous screen	Easy to reach group had higher uptake Text reminder had lower uptake Previously screened had higher uptake	(318)
Visser	2005	Retrospective Cohort	January 1995 to December 2002	Netherlands	-	Country of birth	↑ in Dutch women	(319)
von Euler-Chelpin†	2008	Retrospective Cohort	April 1991 to March 1999	Denmark	-	Location Age Civil status Type of citizenship Education	↑ in Funen ↑ younger women ↑ married ↑ non-immigrant ↑ medium education	(320)

Wilf-Miron	2011	Retrospective Cohort	November 2008	Israel	157928	SES Ethnicity Immigration status Insurance supplement volunteered	↑ affluent ↑ non-arabs ↑ non-immigrants ↑ owners of voluntary supplement health insurance	(321)
Werneke	2006	Retrospective Cohort	1996 to 1998	United Kingdom	-	Mental illness	↓ women with mental health problems ↓ ↓ psychosis patients ↓ receiving enhanced care	(322)
Williams	1989	Cohort	-	United Kingdom	450	Intervention type Appointment letter Open ended invite	↑ screened at first contact (both groups)	(323)
Woodhead†	2016	Retrospective Cohort	2012 to 2013	United Kingdom	26010	Mental illness	↓ women with mental health problems	(324)

							↓↓ bipolar affective disorder	
Yarnall	1992	Retrospective Cohort	1985 to 1988	United States of America	-	Guideline changes (admin procedure)	↑ after health assessment form changes	(325)
Zidar	2015	Cohort	2011 to 2012	Sweden	52541	Age	↑ in younger women	(163)
Zackrisson	2004	Retrospective Cohort	1990 to 1993	Sweden	32732	Age Swedish born	↑ younger women ↑ Swedish women	(136)

8.1.5 Narrative summary

8.1.5.1 Demographics

Ethnicity

From data that could not be combined with the quantitative analysis, minority groups repeatedly had lower rates of uptake compared to the majority populations (140, 141, 299, 321, 329).

Further papers contributed ethnicity data that could not be meta-analysed. In 2013, Ore et al. compared BCS attendance for women born in Israel or other countries. Israeli women had the lowest uptake (50.8%) compared with European and American (58.8%) or Asian and African (55.0%) (299). Another study in Israel found the odds of Arab women attending BCS were 11% lower than non-Arabs, OR 0.89 (0.80, 0.99) (321).

Using name recognition software which assigned each woman to a religio-linguistic group, Szczepura et al. investigated attendance and ethnicity to assess its effect by proxy on BCS uptake in the UK. Of those believed to be Hindu-Gujarati, the odds of attending BCS were not significantly different from non-Asian women. The odds of attending BCS were 32% lower for Hindu Other women compared with non-Asian women, OR 0.68 (0.56, 0.84); 60% lower for Muslim women compared with non-Asian women, OR 0.40 (0.35, 0.46); and 21% lower for Sikh women compared with non-Asian women, OR 0.79 (0.72, 0.88), $p < 0.0001$ (140).

Race data were not included in the pooled quantitative analysis as race was defined differently in studies.

Language

A study in Australia suggested women who spoke a northern European language at home were most likely to attend BCS (85.95%). This was closely followed by southern European speaking women (82.0%). The language associated with the lowest rate of uptake was South-East and South-West Asian (73.09% and 73.55% respectively) (141).

In Canada, those who preferred to speak English were more likely to attend screening than those who preferred to speak other languages. Of women preferring English, 76.94% attending breast screening compared with 59.65% of those speaking another language (255).

Religion

O'Reilly et al. investigated religion as a predictor of uptake. Results of the large population-based study showed that odds of attending were 17% higher for Protestant women compared with Catholic women, OR 1.17 (1.11, 1.23) and 28% lower for atheists compared with Catholic women, OR 0.72 (0.67, 0.78) (331).

Nationality

Attendance appears to be highest among women that are native to the country studied (75, 131, 252, 264, 305, 319, 320).

Lagerlund *et al.* analysed uptake of BCS with country of origin. Women born in Sweden or Nordic countries showed the highest rates of uptake (90.4% and 88% respectively) (75). Women born in northern America had the lowest rates of uptake within this studied population (73.6%) as did women from 'other European descent' (79.7%) (75).

Vermeer et al. investigated attendance in the Netherlands and the effect nationality may have. It was found that natives were most likely to attend BCS (81%). Women born elsewhere in Europe or other western countries had attendances ranging between 65% and 69%. Attendance of women from non-western countries were 56% (252).

Another study conducted in the Netherlands also investigated uptake of BCS by country of birth (319). Attendance was 79% (n=572347/724490) for women born in the Netherlands. For women born in western countries, attendance ranged from 59% to 71%. For women from a non-western country, uptake ranged from 37% to 59%. Overall, total attendance was 76% (n=626,936/824,916) (319).

Pelfrene et al. found that women born in Belgium were more likely to attend BCS (22.8%) compared with women born elsewhere (13.5%) (305). Zackrisson et al. also

found in Sweden, women born there were more likely to attend screening (68.5%) compared with those born elsewhere (51.5%) (131).

Von Euler-Chelpin *et al.* showed higher rates of attendance for Danish women (54.0%) compared with immigrant or descendant women (40.0%) (320). RR estimates comparing never attenders versus always attenders estimated immigrant women had a 80% higher risk of being never attenders when compared with native Danish women, RR 1.81 (1.64, 2.01).

Berens *et al.* investigated uptake of BCS in women of Turkish origin living in Germany. Surprisingly, those women with Turkish origin have OR 1.17 (1.14, 1.21) of participation in BCS than women without Turkish origin (264). Attendance at BCS by women in Germany of Turkish origin was 52.3% (264).

Insurance

Data that could not be combined with previous quantitative data on insurance are discussed here. In Israel, 51.5% of those who did not have insurance attended BCS compared with 70.9% of those who did have insurance (321).

From a study in the USA, Taylor *et al.* provided only percentage uptake rather than actual numbers who attended. However, 29% of those with Medicaid (free insurance for those in need), 36% of those with Medicare (free insurance for those aged over 65years), 34% of those with commercial insurance and 11% of women without insurance attended BCS (315).

In Korea of those with national health insurance and a premium under 50% (meaning they have no out-of-pocket expense to receive mammography), 62.1% attended compared with 62.6% attendance of those with a premium over 50% (and therefore incur a 10% out-of-pocket expense to receive mammography) (298). Of those with medical aid program, 46.9% attended (298). A different study found lower rates of attendance, 21.2% of those with national health insurance and 10.5% in women with medical aid program insurance (284).

Age

Papers which only presented percentage data provided insufficient information for combining into the quantitative analyses and therefore will be discussed briefly below.

In the late 1990s, two studies found similar rates of uptake across all age groups across the UK and USA (292, 308). This finding was consistent in an intervention study conducted in 2003 (317).

In European studies reporting only percentages, uptake patterns appeared inconsistent. Uptake was apparently higher in younger women aged 40 to 49 years (22.7%) in Belgium compared with 20.3% in women aged 60 to 69 years (305) and a U-shape attendance pattern was observed in Sweden (163). In Italy uptake was found to be higher in younger (aged 50-54 years) women before 2000 but higher in older (65-69 years) woman after 2005 (7, 272, 444).

Of papers analysing non-attendance, higher rates were found in older populations in the USA where 60.3% of the sampled population did not attend BCS (332).

SES

Some studies reporting SES data could not be analysed with the above data as they did not provide data on the proportions of those invited who attended. Of those studies conducted internationally, uptake was consistently reported as higher in higher SES groups from the UK (140, 166), Israel (299, 321) and Sweden (288). Higher uptake in higher SES groups was also consistent across studies which used employment status and job position as a proxy for SES in Denmark (278), Sweden (75), Northern Ireland (283) and Norway (330).

In the UK, Szczepura et al. conducted a study investigating uptake of mammography at different screening rounds (140). Round one information was entered into the quantitative analysis. The pattern of uptake across rounds appears consistent however with the largest percentages of uptake occurring in those least deprived (80.99% compared with 61.39% in round two and 82.18% compared with 67.6% in round five) and tapering of attendance over time (140). Vaile et al. also gave rates for

rural and provincial uptakes, both of which perhaps surprisingly displayed higher uptakes in working class women compared with middle class women (171).

In Sweden, Matson et al. found 73.6% of high SES women attended screening compared with 59.9% of the low SES women (288).

In the UK, a study reported attendance at breast screening by IMD. It reported that of women in the least deprived quintile, 71% (n=1265/1773) attended within three weeks of their appointment and 7% (n=118/1773) did not attend. Of the lowest quintile and most deprived women, 49% attended (n=1285/2603) and 36% did not attend (n=947/2603). Percent of women who opted out (either temporarily or permanently) remained fairly constant across all groups and ranged between 4% and 6% (166).

Lagerlund et al. (75) found, in Sweden, the highest uptake was in 'skilled blue collar workers' and 'intermediate white collar workers', both with 92.7% uptake. The lowest uptake was found in those who were not employed, which did include the retired population (82.2%) (75).

Jensen et al. (278) found in Denmark, of those who attended screening 55.5% were employed, 25.1% retired and 12.4% unemployed. Only 0.5% of women screened were social welfare recipients (278). A study in Northern Ireland found the highest percentages of uptake were in women who were self-employed (78%) compared with the lowest in the unemployed group (63.9%) (300, 331). Another study from this region found the same low rates of uptake in the unemployed group (50.3%) (283).

There was insufficient quantitative data to meta-analyse the data for uptake by car access (121, 278, 300). O'Reilly *et al.* found the odds of attending BCS were 26% lower amongst women with one car compared to women with two or more, OR 0.74 (0.70, 0.78) and 63% lower amongst women with no car, OR 0.37 (0.35, 0.39) (300). In Portugal, of women who attended screening, 52.2% of women had use of their own car compared with 52.5% of non-attenders (121). In Denmark, women without use of a car were more likely to be non-attenders, unadjusted RR 2.22 (2.16, 2.28) (278).

8.1.5.2 Health

Smoking

Rodriguez *et al.* only provided data about attendance of non-smoking women and so could not be included in the quantitative analysis. They reported 94% of women attending mammography were non-smokers and 90% of non-attenders were non-smokers (306).

Co-morbidities

Meta-analysis was only conducted on three out of the four studies that reported primary care visits as a predictor of uptake as McCarthy *et al.* did not categorise the number of visits similarly to the other papers. However McCarthy *et al.* reported the opposite trend (292). They reported lowest rates of uptake (47.7%) in women who have had only one visit in the last year compared with 63.5% attendance for women who had 2-10 visits and 55.5% attendance for women that have had more than ten visits in the last year.

A study conducted in the University of Alabama also found no significant difference between women who were and were not compliant with government recommendations to be screened biennially depending on the number of comorbidities (289).

Mental health

In a randomised controlled trial conducted in Massachusetts, the odds of attending for women who had had depression were 5% lower compared with women without a depression diagnosis in the last year, OR 0.95 (0.71, 1.28), $p=0.74$ (332). In general, women suffering from mental health related chronic conditions appear to have lower attendance at BCS compared with other women. Woodhead *et al.* found that in the last three years, 65.7% of women in London without a serious mental illness (SMI) attended breast screening. Of women diagnosed with schizophrenia, 55.2% attended (OR 0.64 (0.5-0.82)), 50.8% of those with non-organic psychoses attended (OR 0.54 (0.33-0.87)) and 62.0% of women with bipolar affective disorder attended (OR (0.58-1.26) not significant) (324). Werneke *et al.* found that of women receiving enhanced care for their mental illness, 34.5% attended BCS (95% CI 27.3, 41.8) and for those

diagnosed with psychosis 30.6% attended (17.7, 43.5) (322). This is compared with a reference population attendance at breast screening in this study of 57.1% (56.6, 57.6). However, Merrick *et al.* found no significant difference in the odds of attending BCS based on their depression diagnosis (332). These rates are low and this is potentially because only 38.0% of the overall sample had previously attended mammography and as shown in this review, previous attendance is associated with uptake. However, this study used a sample of only 4,427 women and therefore caution should be used in interpreting these results.

Hospitalisation

Meguerditchian *et al.* found no significant difference between attendance of women who had and had not been hospitalised in the previous year, OR 0.97 (0.93, 1.02) $p=0.21$ (293).

A study in the USA found that women in long-term care were less likely to attend screening. Only 41.2% of those in long-term healthcare facilities attended screening compared with 52% of women not in long-term care (289).

HRT

Data on HRT were extracted (141, 309). Groups were defined as never or ever users of HRT. There were not enough data to quantitatively analyse this predictor. Unadjusted risk ratios estimate Australian women that are using HRT are less likely to be non-attenders BCS, RR 0.90 (0.87, 0.93) compared with women who do not use HRT (141). Seeley *et al.* compared uptake of British women who do and do not use HRT (309). Women using HRT were found to be significantly more likely than women not using HRT to attend mammography (92.7% vs 85.7%, chi-squared=9.0 degrees of freedom=1, $p<0.01$).

Family history

Two studies provided data about family history of BC (268, 306). Rodriguez found no significant difference in attendance of women with or without family history of BC, OR 1.03 (0.62, 1.68) (306). A study from the USA found of women who had family

history of BC 76.3% were up to date in mammography compared with 68.6% who were up to date but had no family history (268).

Previous health behaviours

In Barcelona, 59.5% (n=147) of women who self-reported obtaining a cervical screen periodically attended BCS compared with women who did not previously have a cervical screening (306). In the States, women who had had a pap smear within the last six years had higher odds of attending BCS, OR 7.1 (5.3, 9.5) (289). In the UK, 92.6% women who reported a previous smear test attended mammography compared with 60.7% of those who had not had a smear test (308).

McCarthy et al. reported on previous visit to gynaecologist: 69.9% (n=575/823) of those who had visited a gynaecologist (n=823) and 58.6% (n=3478/5936) of women who had not visited the gynaecologist, attended screening (292).

Data about breast self-examination (BSE) were extracted for the review (125, 306). Data were combined into regular (performing BSE at least once a month or more as recommended) or women with no regular history of BSE or have never conducted BSE. More women who attended BCS reported practising BSE occasionally or monthly compared to non-attenders. Of women reporting BSE their OR of attending BCS was 1.99 (1.23, 3.23) compared with women who did not practice BSE (125).

Psychosocial

Data were extracted about perceived risks of breast cancer (125, 306).

In Barcelona, 83% of women attending BCS (n=107/129) felt their risk of BC can be reduced [by BCS] (306). Those who knew the preventative role of BCS had an OR of attending mammography of 2.66 (1.14, 6.18) compared to those who did not (306).

In a sample of women from Portugal who attended screening 11% had 'good' knowledge about mammography, 85.7% had 'poor' knowledge and 3.4% were 'without' knowledge (121). Of women attending BCS, 73% of women had correct knowledge about mammography frequency and 27% did not have the correct knowledge about frequency. Of women not attending screening, 48.6% had the correct knowledge about frequency compared with 51.4% who did not (121).

The results presented by Aro *et al.* present a more complicated picture. The odds of attending BCS were 100% higher for women who believed their risk of BC was moderate compared with women who believed their risk to be low, OR 2.0 (1.54, 2.61). However, the odds of attending were 9% lower for women who believed their risk to be high when compared with women who believed their risk is low, OR 0.91 (0.62, 1.34) although this result is not found to be significant. Finally, the odds of attending were 70% higher for women who did not know about their risk of BC compared with women who believed their risk to be low, OR 1.70 (1.27, 2.27) (125).

In Finland Aro *et al.* (125) recorded women's expectations of pain. Any expectation of pain was predictive of non-attendance with OR 0.69 (0.54, 0.89).

Kee *et al.* (281) interviewed six hundred women in the UK to identify attitudes of women who attended and did not attend screening. Overall those who believed that breast cancer screening does more harm than good had an attendance rate of 27.3% compared to a rate of 59.6% for women who believed that breast cancer screening does more good than harm.

Social support

Jensen *et al.* investigated the association between social support (as defined by frequency of contact, instrumental and emotional support) and attendance at BCS (280). Figure 67 below shows the reported social supports felt by women either attending or not-attending mammography. As shown, attenders were more likely to be social supported, either instrumentally or emotionally.

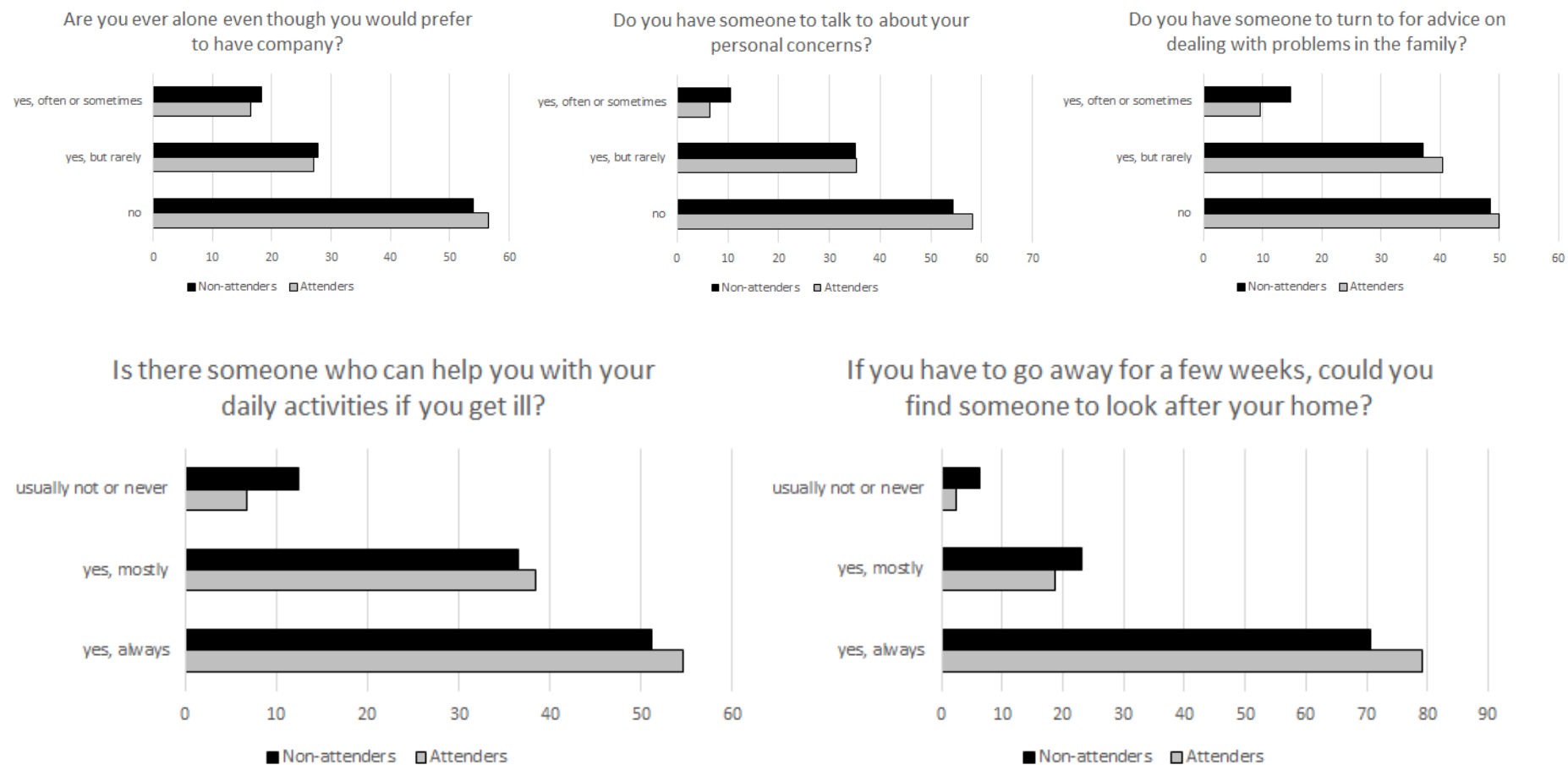


Figure 69. Attendance at mammography reported by constructs of social support as measured by Jensen et al.

Violence

Gandhi et al. investigated the effects on BCS of intimate partner violence (IPV) among urban minority women (270).

Of those who were non-victims, 34.5% of women were up-to-date with mammogram screening. Of those who were subject to emotional abuse, 53.8% were up-to-date with mammogram screening. Of women who were physical and/or sexual abuse victims, 15.4% were up-to-date with BCS. The OR of attending mammogram for women aged over forty years who were the victims of physical and/or sexual abuse was 0.13 (0.02-0.85) compared with victims of emotional abuse only (270).

Combining all the data presented, of women who suffered any type of abuse, 38.1% attended compared with 34.5% of those who suffered no abuse. Of women who suffered specifically physical or sexual abuse only 15.4% attended.

8.1.5.3 Other

Time

Data were extracted from four papers which explicitly gave numbers of women who attended and did not attend BCS over different time periods, between 1998 and 2008

Urban-rural

Tatla et al. investigated women living in an urban setting and receiving a recommendation to attend by a healthcare professional, 75.84% (n=26592/33047) attended screening compared with 74.55% (n=6455/33047) attending of women who did not receive the recommendation. Of women residing in a rural location and receiving the recommendation from a professional, 80.54% (n=7701/10203) attended screening compared with 79.73% (n=2502/10203) who had no recommendation (255).

In Northern Ireland, women living in rural settings had the highest rates of attendance (80.3%) compared with intermediate (78.0%) and urban (69.0%). The study developed a model that adjusted for age, marital status, SES, health status and area of residence and found that when compared with urban women, the odds of

attending mammography were 56% higher among living in an intermediate area, OR 1.56 (1.47, 1.65), $p < 0.05$ and 54% higher for women living in a rural environment, OR 1.54 (1.45, 1.64), $p < 0.05$ (300).

Leung *et al.* compared the uptake of mammography of women in Australia and Scotland. In Australia the higher rates of uptake were found in those residing in urban areas (78%) whereas the opposite was true in Scotland where higher rates of uptake were found in women living in rural (79%). A logistic regression analysis found in Scotland, the odds of attending BCS were 11% higher among women living in a rural area compared with those from an urban area, OR 1.11 (1.04, 1.19), $p < 0.05$. A non-significant difference was found in Australia, OR 1.10 (0.96, 1.25), $p > 0.05$ (286).

Fleming *et al.* found highest rates of uptake were observed in women who reside in rural areas (51.4%) compared with 28.6% of women who live in a town and 20.0% of women who live in a city (168).

(7, 79, 272, 284, 285, 444). Percentage attendance over time, is presented in Figure 68.

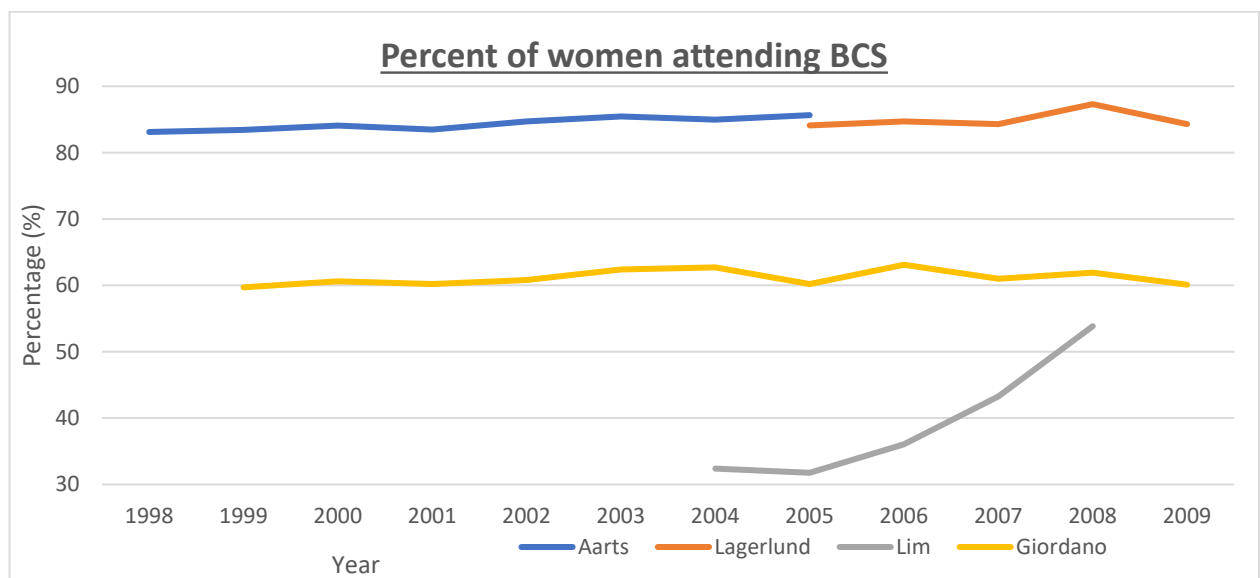


Figure 70. Percentage of women attending BCS over time. Lim 2010 studied women in Korea which may explain the big difference in percentage uptake compared with the other studies that investigated uptake in The Netherlands and Sweden.

Distance to screening site

For this section, distance data were merged into close, intermediate and far based on the results reported in each study.

An Australian study examined if uptake was affected by distance to screening site and if this varied by SES. Women in the lowest 25% SES group were compared with the 'other' SES groups. They found for women in the lowest 25% SES, uptake was higher in the groups closest to site (12.1% attendance for women within a 3km radius of the screening site compared with 8.7% attendance within those travelling 6km or more) (276). However, in 'other' SES groups, uptake ranged from 8% to 8.1% in the furthest and closest groups respectively showing only a small difference (276).

Hyndman *et al.* that 12.1% of women attended BCS if they lived within 3km of the screening site compared with 8.7% if they lived 6 km from the site (276). Jensen *et al.* found an association between distance to screening site and non-participation significant at and above 40km. For women living >40km-60km the prevalence ratio of non-attendance was 1.23 (1.15, 1.32) and 1.27 (1.15, 1.40) for women living >60km away from the screening site (278). Another Jensen *et al.* paper investigated a similar pattern of non-attendance but data was provided only in association with GP attitude to screening and therefore cannot explicitly be extracted (279).

Type of screening site

Sites were defined as fixed or mobile clinics with one paper also reporting relocatable site data which is approximately similar to mobile. McCarthy *et al.* studied American women. For those who could receive mammography at their usual clinic site without having to travel to a new location 63% attended screening (n=2982/4733). This is compared with 52.9% (n=1072/2026) attendance at mammography for women that had to travel to a new site as they could not obtain mammography at their usual clinic site (292). Offman *et al.* found in the UK that 74.0% of women attended at a static screening unit compared with 75.1% of women invited to a mobile site (297). O'Bryne *et al.* found that women invited to a relocatable site were at higher risk of non-attendance than women at a fixed site, RR 1.39 (1.30 1.48) and women invited to a mobile site were less likely to be non-attenders in Australia, RR 0.89 (0.83, 0.94) (141).

Interventions

Many different studies found increased uptake in women receiving either invitations to attend screening that included a GP signature (273, 314, 329), a specific appointment time (275), out of hours option (297), supplementary follow up such as a reminder letter (302, 323), tailored information (294) or tailored counselling (317).

Decision aid vs standard information

Bourmaud *et al.* found that of women given a decision aid when deciding whether or not to attend BCS they were 9% less likely to attend compared to women in the control group, OR 0.91 (0.84, 0.97) (265).

Invitations

There was no difference between attendances rates for women receiving a physician-endorsed invitation letter (47.7%) attended compared to those who received a standard facility invitation (46.6%) (329).

In the UK however women who received a postcard reminder had an odds of attending of OR 1.92 (1.36, 2.71) compared with women receiving usual care. Women who received both the GP letter and the reminder had an odds ratio for attendance of 1.95 (1.38, 2.74) (314).

Vidal *et al.* investigated the use of text-message reminders to improve BCS participation in Spain (318). The odds of attending BCS were 63% higher amongst women in the group who received a text-message reminder compared to those who did not, OR 1.63 (1.49, 1.78). More women in the text-message reminder group rescheduled their appointment (8.3% compared with 7.0%). Furthermore, less of the women in the text-message reminder group attended their rescheduled appointment, OR=0.69 (0.49-0.96) (318).

Hurley *et al.* investigated the use of a specific appointment time in the invitation. They found that 35.1% attended of those receiving a letter with a specific appointment time compared with 9.1% who received a letter without the appointment time (275). These findings were not significant.

Results from Williams *et al.* established that sending an invitation with an appointment time enhances attendance. Of women who were given an appointment asked to alter the time if it was not convenient 86.2% attended. The comparison group were asked to return a form and list convenient times before being sent an appointment, of this group 75.5% attended (323).

An intervention which provided tailored letters addressing individual barriers to attendance increased odds of attending BCS compared to women receiving usual care, OR 2.90 (1.59, 5.29). A combined technique which used these letters and a motivational interview to discuss barriers and self-help strategies to overcome them gave an OR of 2.15 (1.17, 3.94) (317).

In Australia one letter with an appointment is standard practice. An intervention added a reminder letter at six weeks and found odds of attending increased by 61% compared with those receiving standard practice letters, OR 1.61 (1.08, 2.40). Adding a phone call to this letter gave non-significant results (302).

In the UK, previous screening history was used to provide a tailored invitation to women for mammography. Of those who received the tailored invitation, 62% attended compared with 60% of those receiving the standard invitation (294).

Incentives

Merrick *et al.* looked at uptake in groups receiving different incentives in the USA. In the women in the control group, 11.9% attended screening. This was similar to those receiving a \$15 gift card (11.7%). For women receiving a lottery ticket to win \$250, 12.1% attended and in women who had the choice between gift card and a lottery option 13.4% attended. However, odd ratio estimates suggest that none of these options are statistically different from the control group at the 95% confidence level. Additionally the sample included in this study had a mean annual income of over \$70,000, and 11% reported a depression diagnosis within the last twelve months. It is unlikely that this sample is representative of the general population (332).

Other interventions

Richards *et al.* compared uptake in control groups to those with a flag in their GP notes. For the flag group, if their GP accessed the woman's notes during the screening round, they should discuss mammography with the woman. Only half the flags were activated, but 77.7% (n=1000/1287) of women with an activated flag attended BCS compared with 54.3% (n=609/1121) attendance of women without an activated flag (160).

In 1987 a health assessment form was introduced to healthcare centres in America to improve physicians preventative care discussions and reminders to patients. At the study site, 7.3% of patients (n=59/807) completed a mammography screening for the two years prior to the health assessment form. Within the two years after the health assessment form was introduced, 32.0% (n=333/1040) patients completed a mammography screen (325). These women in the 'before' part of the study were not the same as those in the 'after' part and the effects of this study design should be considered when evaluating the results.

8.1.6 Narrative summary of sum to 100% data

Some studies provided characteristics of attendee or non-attendee population rather than attendance rates for the invited population. Those papers will be discussed in the section below.

8.1.6.1 Demographics

Age

The data discussed below could not be combined into the quantitative analysis as the age groups did not comply with the merged age bandings. Otten *et al.* (301) found for women under fifty years, uptake was highest in the first round of screening (87.2%) and tapered to 68.2% in subsequent rounds. This pattern of tapering uptake was consistent across all age groups in another paper by Peeters *et al.* (301, 303).

Mayer *et al.* studied an intervention that compared the effects of a physician invitation letter compared with a letter from the screening centre (329). They found uptake was higher in older women in the group receiving the facility letter (65.9% in women over sixty-five compared with 34.1% in the 50-64 age group) in contrast with

higher attendance from younger women in the group receiving the physician letter (68.9% and 31.2% respectively) (329).

Vaile et al. (171) found that inner city women had the lowest uptake rates (76.4% and 79.5% for women aged either less than or over fifty-five years respectively) compared with women living in provincial (83.6% and 82.3%) or rural habitats (88.3% and 88.1%) (171). This data also shows lower uptake in the older age categories.

McCarthy et al. showed that in the USA uptake was similar across the age categories (59.9% and 60%) (292). In 1997, Rutter et al. also found similar uptake rates across the ages in the UK (92% and 90.3%) (308). However, these papers both look at limited age boundaries, women are categorised either as the 'younger' or 'older' age groups cut off at 65 and 55 respectively rather than more specific age bandings.

The percent of Belgium women attending screening of those aged between 50 and 59 years was 24.7% (305). Contrarily, for Swedish women, rates of uptake were inconsistent across the age ranges (163). In Italy, Giordano et al. studied attendance rates across time for different age bandings (7, 272, 444). Attendance appears to be higher for younger women in 2000 (62.8% in women aged 50-54 years compared with 54.6% in those aged 65-69 years) (444). However, this pattern changes over time, starting in 2005 uptake is higher in the older women (56.4% compared with 59.1%) and continues until 2008 (58.5% and 60.2% for the same age categories) (444). This is somewhat expected as the women aged 50-54 in the initial year analysis 2000 age with time and will become part of different age cohorts in later analyses. However, looking at the total attendance percentages in the studied regions, uptake has remained fairly constant over this same time range (60.6% to 60.2% to 61.9%) (444). A Swedish study found that in 2002, uptake was highest among those in the younger age groups, 40-49 year olds (90.2%), compared with 85.5% in the oldest age group, 70-74 year olds (75). In the USA, Merrick et al. found high rates of non-attendance at BCS within their sample population, ranging from 85.7% in the 40-49 year old women to 89.7% in the 60-69 year old women (332).

In a UK study, of those who participated, 41% were over 60 years, 27% aged between 55 and 50 and 32% were 49 to 54 years (133).

Some included papers used data that sums to 100%. For instance, a study may have selected all women at a particular centre in a certain timeframe and subsequently identified which demographical group they belong to.

Of these papers, a trend of uptake with age was much harder to observe. Uptake in different age groups appears dependent on the geographical location. In particular, uptake was highest in the younger age groups in the Netherlands (79, 116), Denmark (144, 279, 320, 326), Switzerland (266) and Canada (255, 277). On the contrary, two included studies showed uptake appears higher in older groups in the UK (133, 158). The reproducibility of the Chouliara et al. study is of concern as the sample size was very small. In the USA, uptake was higher for older women (267, 268). May et al. found variable rates of attendance across age groups, again showing how complex the interaction with uptake may be (289).

However, these patterns stated above need to be analysed with great caution. They highlight which women consisted of the study population of which the participants either attended or did not. Therefore these patterns may simply be a reflection of the underlying populations invited to attend screening.

There are lots of factors that may influence a woman's decision to join a study and therefore which may bias the results presented in research. Such factors may include the required time commitment to the research and availability of the woman, it may involve societal pressure to either partake or non-participate, pressure may be observed from simple logistical differences such as was the woman invited to participate in the research?

Scaf-Klomp et al. found only being divorced had a significant effect on attendance. At round one, divorced women were significantly less likely to attend breast screening OR 0.65 (0.47, 0.90) (116).

SES

Wilf-Miron et al. reported only percentages so that specific group totals could not be calculated and this study could therefore not be used in the quantitative analysis. The author was contacted on the 14th July 2017 for more information. In the Israeli

women studied, those with highest SES were more likely to attend BCS than low SES women (72.9% and 64.1% respectively) (321).

Similarly, Ore et al. only reported uptake percentages and in another Israeli study, 62.6% high SES women attended breast screening compared with 61.9% and 53.2% of medium and low SES women (299).

Income

Mayer et al. provided only uptake data and all data sums to 100%, therefore it cannot be combined into quantitative analyses as described before. It suggests that the majority of women attending BCS (44.1%) are earning more than 40,000USD per annum compared with 20.8% of those earning under 20,000USD (329).

Ethnicity, Nationality and Race

Mayer et al. also provided only uptake data regarding women's ethnicity. It suggests that the majority of women attending BCS (87.0%) are white women (329).

Of women who attended BCS in a Danish study, 92.7% were Danish, 1.8% western immigrants and 1.5% non-western immigrants (278, 279). However, this could reflect the underlying population structure and the women targeted for study participation. Another study by the same author has shown that 79.6% of Danish women or women of Danish descent attend BCS compared with 62.9% of immigrant women in Denmark (326).

8.1.6.2 Other

Distance to screening site

In 2013, St-Jacques et al. investigated the effect of distance to screening site for Canadian women (313) which can be found in Figure below. The difference between the results of the review and this Canadian paper could be due to the heterogeneity included. For instance, distances required to travel in Canada are much greater than those in Denmark where much of the review data has been taken from and subsequently women may be more willing to travel 12km as it is considered 'normal' in their society. Additionally, there could be alternative reasons why women who live close to the screening site in the study by St-Jacques et al. may not have attended,

for instance it could be a particularly deprived area of Canada that just happens to be closest to the screening site.

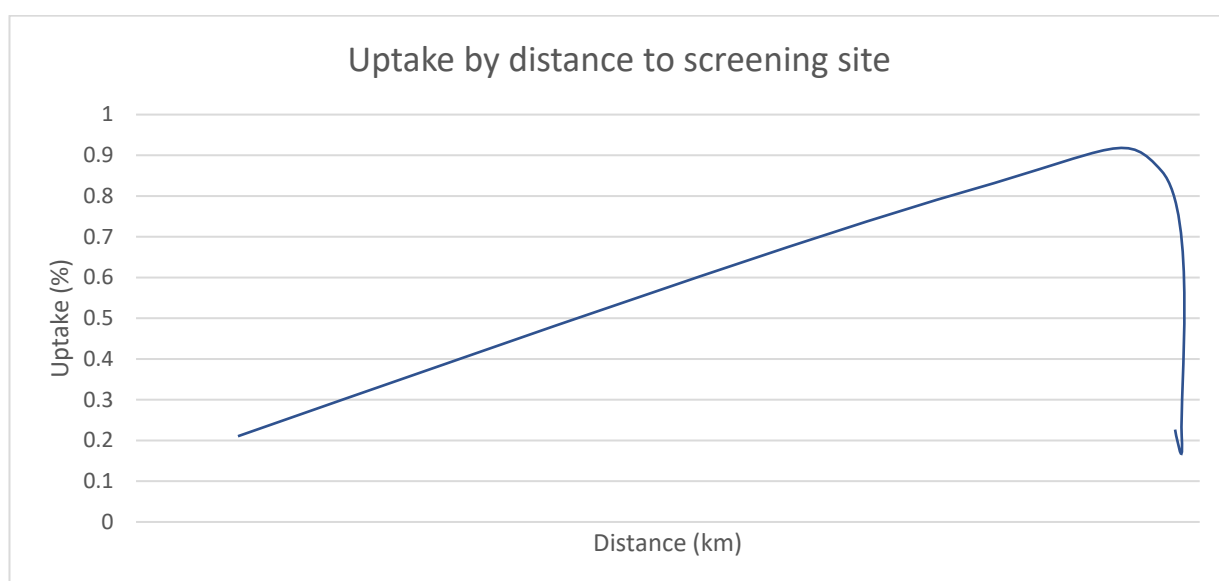


Figure 71. Uptake of BCS by distance to screening site in Quebec, Canada Data taken from (313).

Interventions

Jean et al. investigated uptake before and after the mailing of a letter intervention to women of different ages (277). The difference in uptake between the younger (50-54) and older (65-69) group before the intervention was 38.2% compared with a 7.9% difference afterwards (277).

In 2003 Valanis et al. found higher rates of uptake (49%) in those targeted with the outreach intervention, which consisted of a tailored letter addressing women's barriers to screening and then for those who had not attended initially a tailored telephone call at six months, compared with those with in-reach (39%) who received a motivational interview to discuss barriers and motivation to seek screening and the usual care (38%) (317). Women that received the combined intervention (both the in-reach and outreach services) had an uptake of 48% (317). This pattern was consistent across age categories, for those aged between 50-64 years their uptake was higher (54%, 41%, 38% and 50%) than those aged 65-69 years (30%, 31%, 39%, 41%) (317).

In Italy, a study found that the majority of women receiving a letter signed by the GP were more likely to not attend, ranging from 52.14% and 58.12%, but this appeared

to be dependent on geographical location (273). Of those who did not attend and received a reminder letter from their GP 16.67%, 21.76% and 24.26% attended from the respective study locations (273). Of non-attenders receiving a reminder letter from the screening centre, 8.91%, 20% and 17.13% attended BCS respectively (273).

In Australia a study found that of the women receiving letter 'A' which contained a specific appointment time, 35.1% (n=149/424) attended after the first letter compared with 9.1% receiving letter 'B' (with no specific appointment time) (275). The women were randomly assigned into a follow-up group. Of those assigned to receive a follow-up letter, 37.5% of group A still did not attend compared with 60.6% of group B (275).

At baseline of a Canadian study, 83.3% of women were without a mammogram history. These women were sent an invitational letter (intervention group). After the intervention uptake increased from 7.8% to 23.0% in women aged 65-69 years, remained constant for those aged between 55-64 years and decreased from 46% to 30.9% in those aged 50-54 years (277). This shows different interventions affect women differently.

In the United States, a study compared uptake in usual care, a group who received a mailed reminder letter (timed to arrive three to five days prior to invite) and a group who received a special counselling and education intervention in addition to the previous letters. Uptake was 74.5% in the usual care group, 79.7% in the mailed reminder and 80.3% in the special intervention group (334).

A study in the USA compared mammogram return rates by type of letter received. Of those receiving a physician endorsed letter, 47.7% returned for a subsequent mammogram within one year. Of those receiving a standard facility letter, 46.6% returned. Twenty-eight percent of women receiving no letter (control group) returned for a subsequent mammogram (329).

In 1994 Taplin et al. conducted a RCT in the USA investigating the type of invitation and uptake of BCS (314). They found that for women invited by the primary physician 45.6% (n=154/329) attended, for women receiving just a reminder postcard 58.5% (n=196/335) attended and 61.7% (n=206/334) women receiving the invitation in

addition to the reminder postcard attended BCS. These results are compared with 46.8% (n=154/329) women attended who were assigned to the control/usual care group.

In 2003, Valanis et al. conducted an intervention study comparing eligible women aged 50-69 years and their uptake of BCS at twenty-four months. The inreach programme 'reinforced any clinical suggestions and used motivational interviewing to discuss barriers and strategies to motivate a decision to seek screening' (317). The outreach programme consisted of a tailored letter addressing barriers to obtaining BCS (as identified at a baseline interview) and for women who had not received a mammography after six months, they also received a tailored telephone call. Women in the combined group received both interventions. Of these women, 38% attended in the usual care (control) group, 39% attended of women in the 'inreach' group, 49% attended of the 'outreach' group and 48% attended of the 'combined' intervention group (317).

In 1989 Williams et al. compared types of invite letter. Group one received an invite with an appointment, of these women 69.7% were screened at first contact and 13.8% attended following a reminder letter after three weeks (323). Of women in group two who received an open ended invitation, 64.2% attended at first contact and following the three week reminder a further 9.3% of women attended (323). Non-attenders were sent a further appointment letter and 2.7% of group one and 2% of group two attended respectively (323).

In 2013 within the UK, a study found women receiving the standard invite had an uptake of 73.2% and 77.1% at static and mobile screening sites respectively. Of women receiving the intervention of an invite with an out of office hours for appointment option, uptake was 76.4% and 69.1% for women without this option (297). In another UK a study found 40.1% of women with a first call invite attend BCS compared with 75.6% of women attending their routine recall (135).

Romaire et al. compared the uptake of mammography after the mailing of different types of reminder letters (335). Sixty percent of women receiving a letter with one to two preventative healthcare recommendations attended BCS and 21% did not. Of

women receiving a birthday letter with three recommendations, 59% attended and 19% did not. Of women receiving four to eight recommendations 52% attended and 17% did not. Numbers do not sum to one-hundred here as due to overlap some women received both letters and therefore interpretation needs some caution as attendance cannot be attributed to one letter or another.

An Italian study found 35.4% of women (n=2856/8069) attended screening at their first invite (310). If women did not attend they were sent a postal reminder and a further 7.11% (n=574/8069) of women went for BCS at that stage (310).

A study in Sweden found future attendance was dependent on her first appointment attendance. The likelihood of participation at all future screening rounds was 0.72 if a woman attends her first screening at the first invite round. If a woman attends her first BCS at the second invite round, the likelihood of her attending all future screens is 0.62. (316). This study also evaluated the likelihood of not attending following rounds if a woman was a non-participant. For women who did not participate in the first round, the likelihood of being a permanent non-attender was 0.32 in comparison with a woman who attended the first round and then did not attend at the second round (0.18 likelihood of being a permanent non-participator). (316).

Other

In 2009 the US preventative services task force reviewed the evidence and recommended women aged 50-74 were only to be screened biennially and women younger than fifty were not to be routinely screened (307). This study looked at uptake before and after these guideline changes. The number of women who were screened in line with US recommendations fell from 62.81% (n=6894/10976) to 59.38% (n=6518/10976) in those aged less than fifty years. The number of women screened in line with the new recommendations were down from 69.73% (n=10864/10976) to 60.85% (n=9480/15580) in those aged between 50 and 74 years and was down from 30.47% (n=1469/4821) to 11.43% (n=551/4821) in those aged 75 or over (307).

Shippee et al. provided adjusted OR estimates for different predictors of adherence to BCS health program in America. The results are presented in the table below.

*Table 28. This adjusted model provides predictors of adherence to preventative recommendations for breast cancer. *P<0.05. BMI= body mass index. N=873. Chi²=15.060*. BIC=648.176.*

Predictor	OR (SE)
Age	0.999 (0.021)
BMI	0.977 (0.019)
Stressors	0.888 (0.109)
Education	1.210 (0.136)
Alcohol concerns	0.611 (0.178)
Current smoker	0.607 (0.252)
Married	1.904* (0.541)
Constant	5.997 (8.146)

Meldrum et al. investigated attendances in women who received different invitation letters. Of women receiving a standard letter, 60% (n=922/1531) attended compared with 62% of women who received a tailored letter (n=956/1552) (294).

In Canada Madedonov et al. found that compared with women who had a female physician, women with a male physician were OR 1.05 (1.02, 1.05) more likely to attend mammography screening (287).

8.1.7 Sensitivity analyses

The following section shows the forest plots of the sensitivity and further sub-group analysis of the age predictor data analysed for the systematic review.

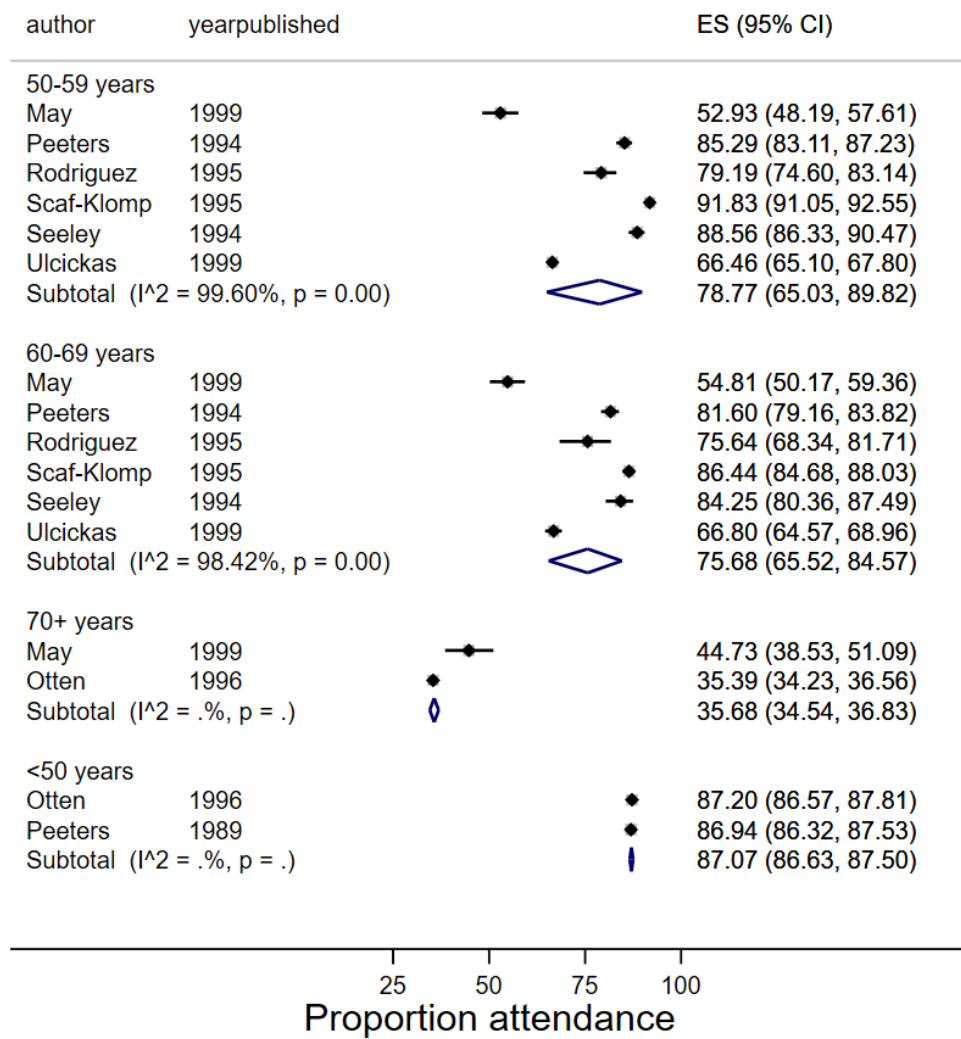


Figure 72. Sensitivity analysis using data pre-2000 only.

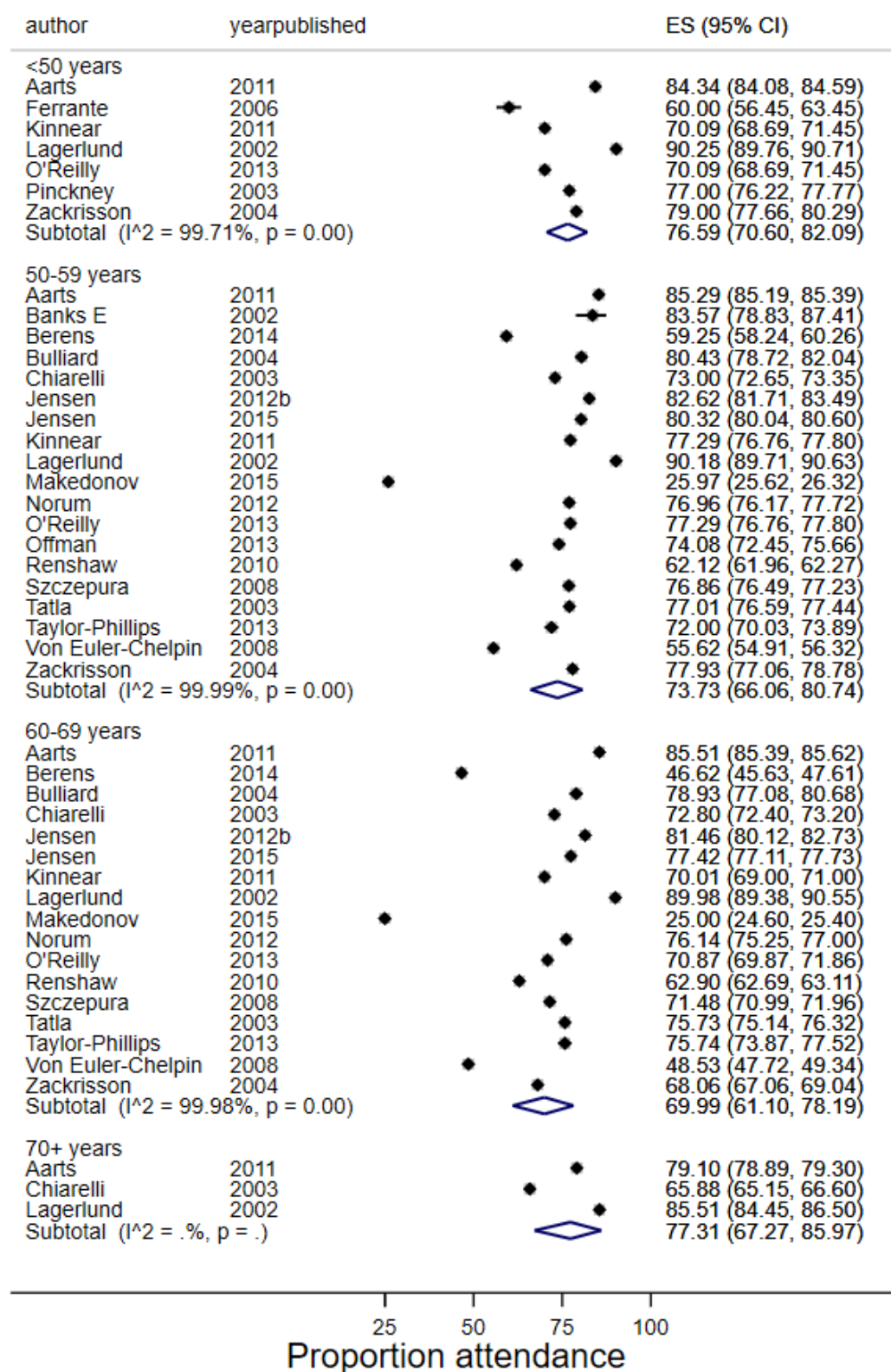


Figure 73. Sensitivity analysis using data post-2000 only

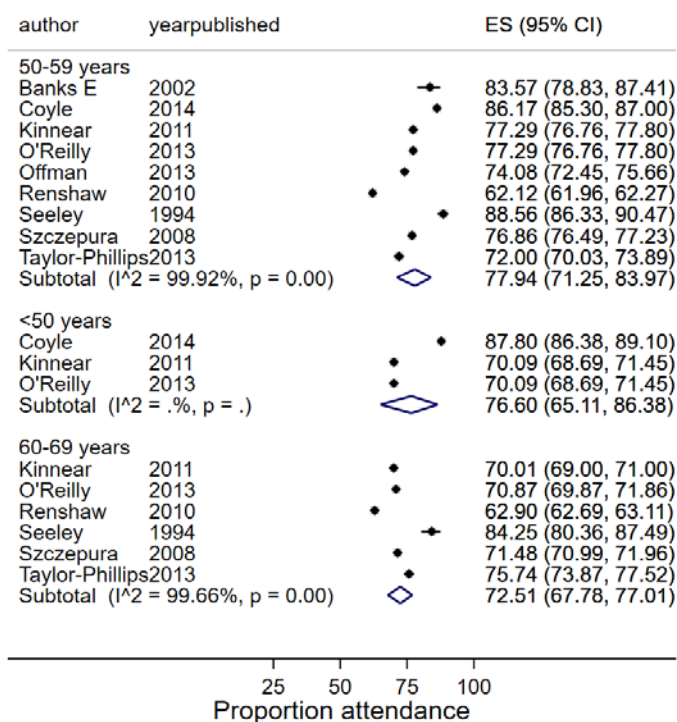


Figure 74. Further sub-group analysis within age predictor. UK and Northern Ireland data only.

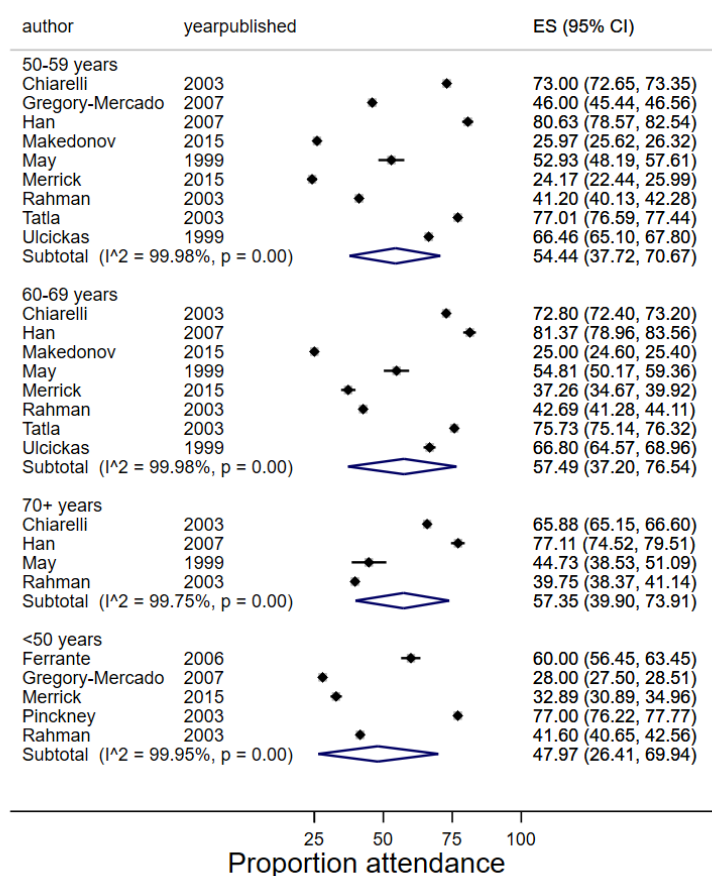


Figure 75. Further sub-group analysis within age predictor. USA and Canada data only.

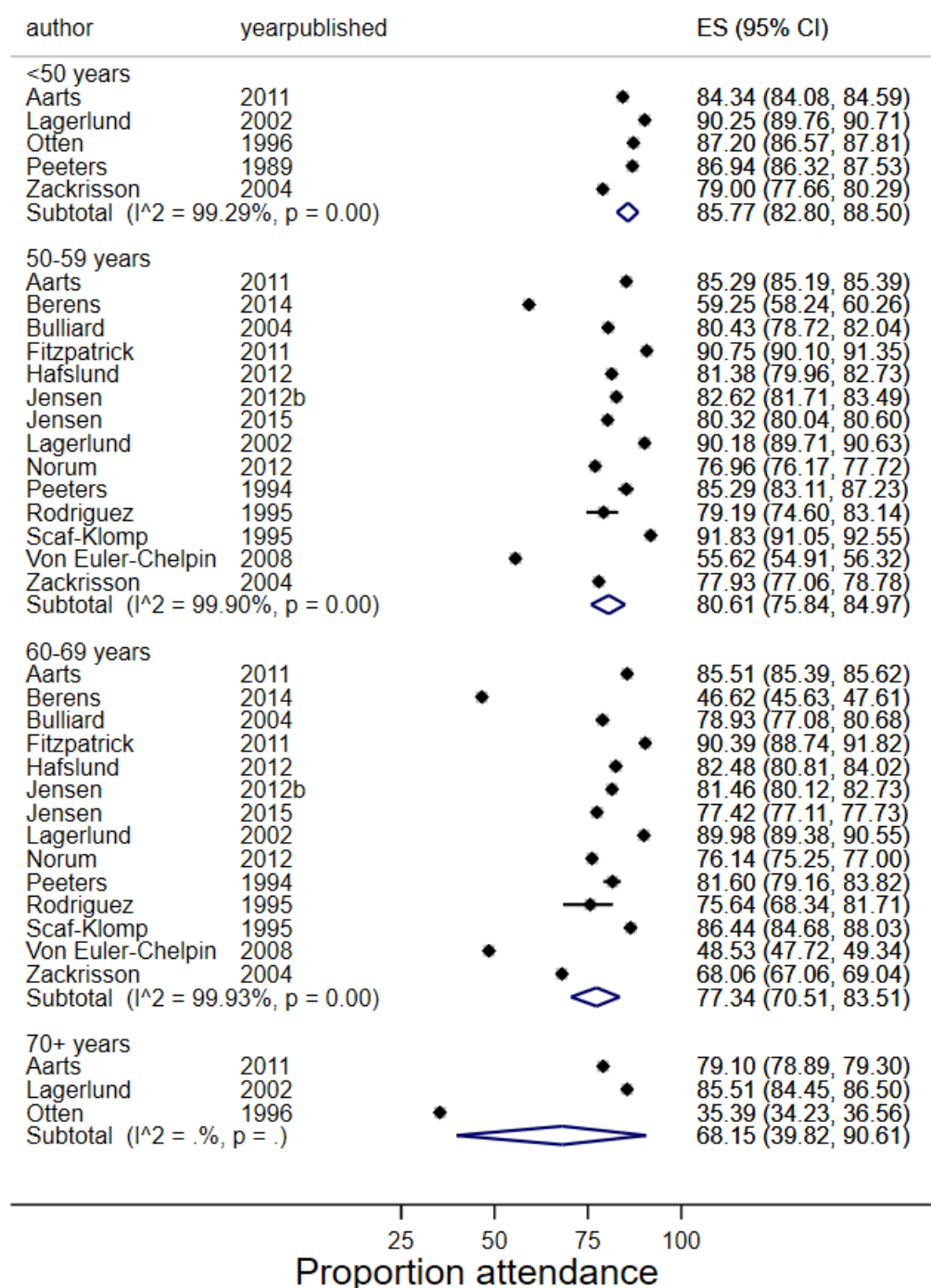


Figure 76. Further sub-group analysis using the age-predictor. Europe (other) data only.

8.1.8 Data analyses

8.1.8.1 Forest plots

Table 29. A summary table indicating forest plot results of the sub-group analysed predictors.

Predictor (number of studies per predictor)	Number of women (invited)	Number of studies included (per sub-group)	Proportion attending	Lower 95% confidence interval	Upper 95% confidence interval
Age (30)	2464825				
<50 years		9	0.79	0.75	0.83
50-59 years		25	0.75	0.68	0.81
60-69 years		23	0.71	0.64	0.78
70+ years		5	0.63	0.47	0.78
Socio-economic status (10)	1957769				
Low		10	0.60	0.48	0.71
Medium		9	0.73	0.61	0.84
High		8	0.73	0.54	0.8
Income (6)	215150				
Low		7	0.64	0.54	0.74
Medium		7	0.73	0.63	0.82
High		6	0.73	0.62	0.82
Housing tenure (4)	223293				
Own		3	0.85	0.77	0.91
Private rent		3	0.74	0.61	0.85
Social rent		1	0.61	0.60	0.63
Education (11)	206074				
High		8	0.71	0.66	0.77
Medium		11	0.85	0.70	0.80
Low		9	0.71	0.63	0.78
None		4	0.75	0.60	0.88
Insurance (4)	4454642				
Free insurance		3	0.53	0.38	0.68
Private insurance		4	0.45	0.16	0.76
Uninsured		1	0.12	0.08	0.18

8.1.8.2 Funnel plots

The plots below indicate the effect of possible publication bias. However, the plots could be estimated outside the 95% confidence interval due to large between-studies heterogeneity present in these meta-analyses or low quality of studies included which can exaggerate some estimates. For this meta-analysis it is likely the heterogeneity and low quality of studies causing the asymmetry (445, 446).

Age

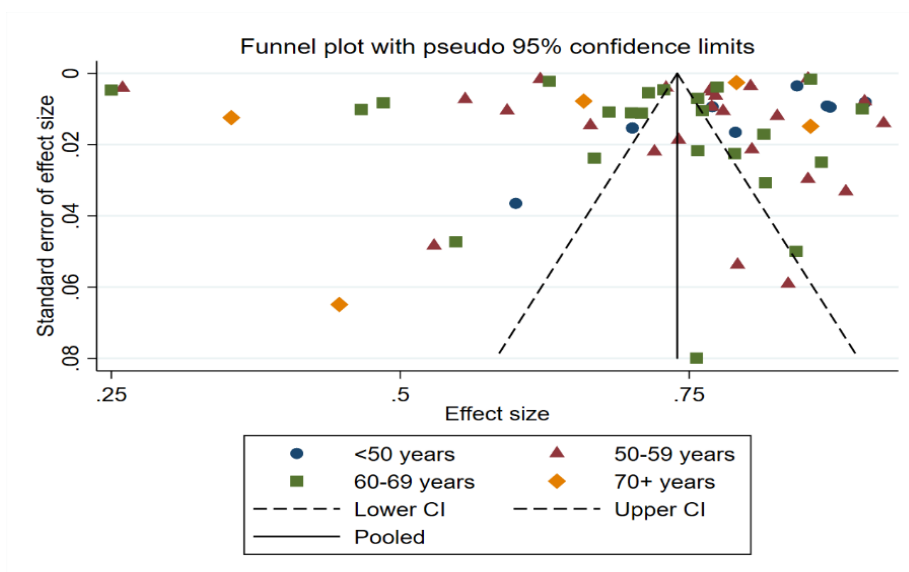


Figure 77. Funnel plot. Points are colour-coded into the age categories.

Smoking status

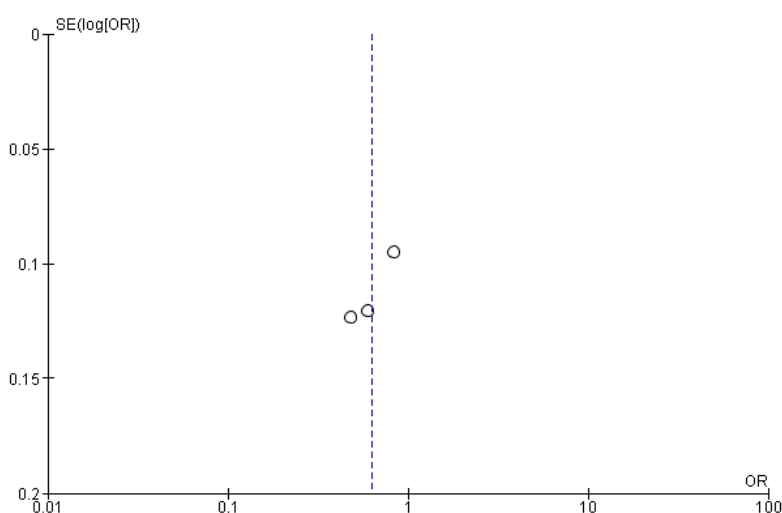


Figure 78. Funnel plot for available smoking data.

Primary care visits

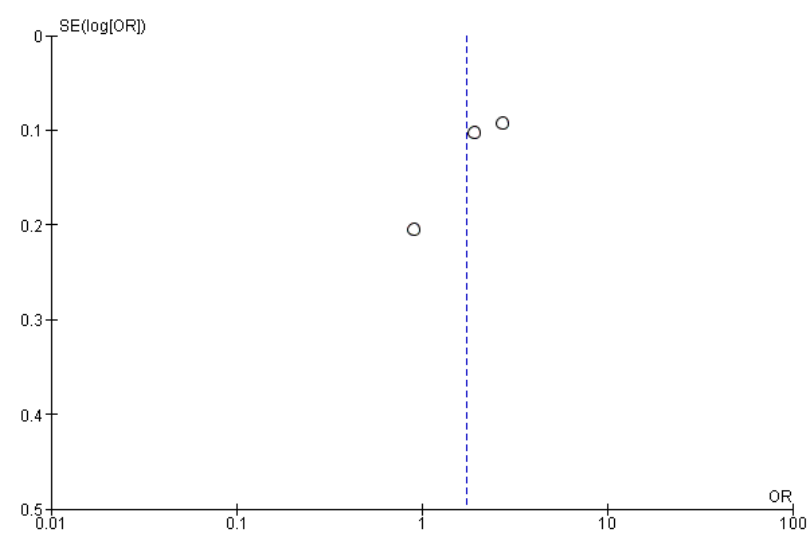
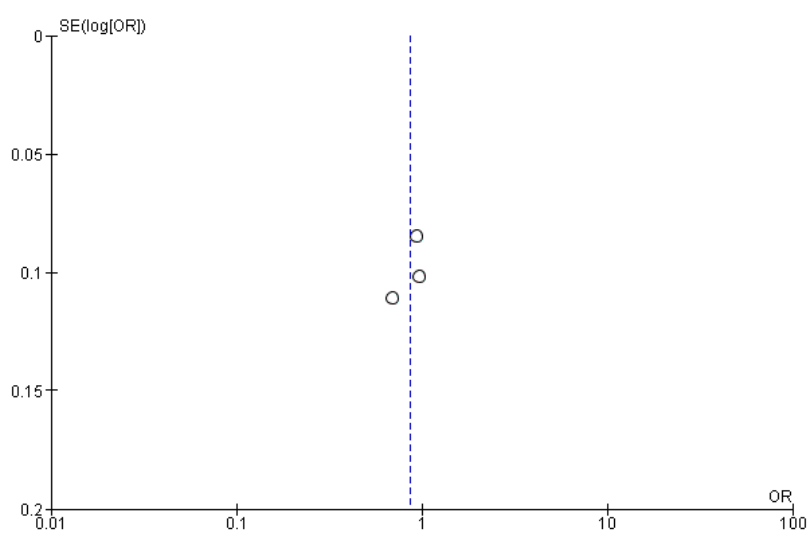


Figure 79. Funnel plot of available primary care visit data

BMI

Table 30. Funnel plot for available BMI data.



Marital status

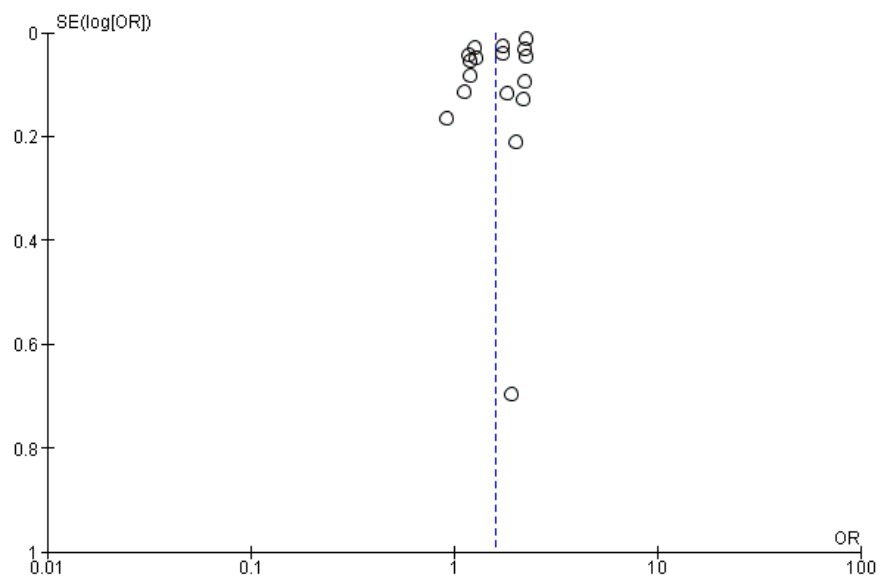


Figure 80. Funnel plot of included marital status data for publication bias.

Socioeconomic status

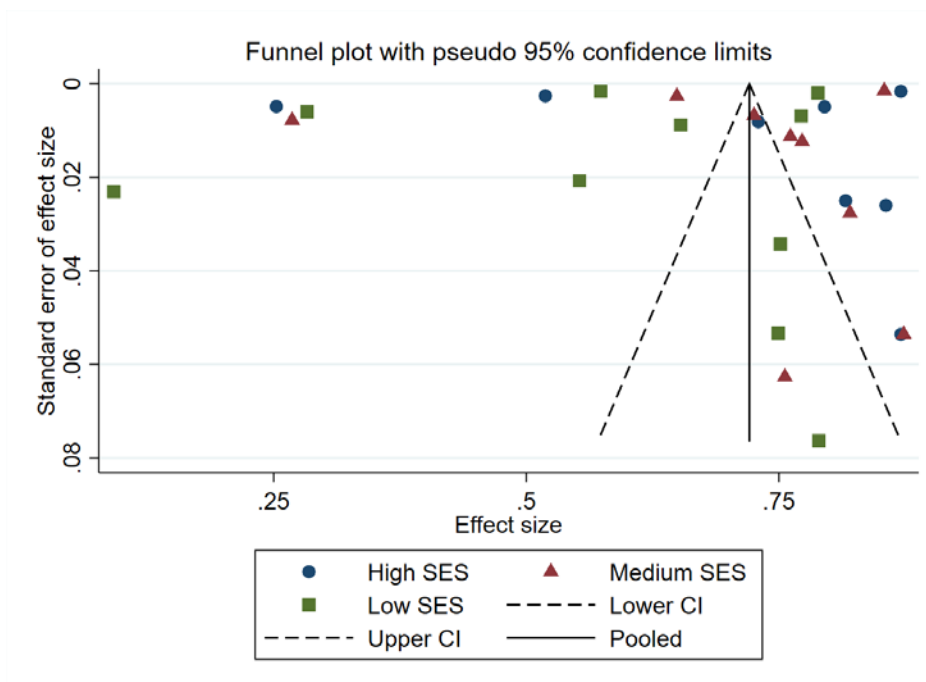


Figure 81. Funnel plot. Points are colour-coded into the socioeconomic categories.

Income

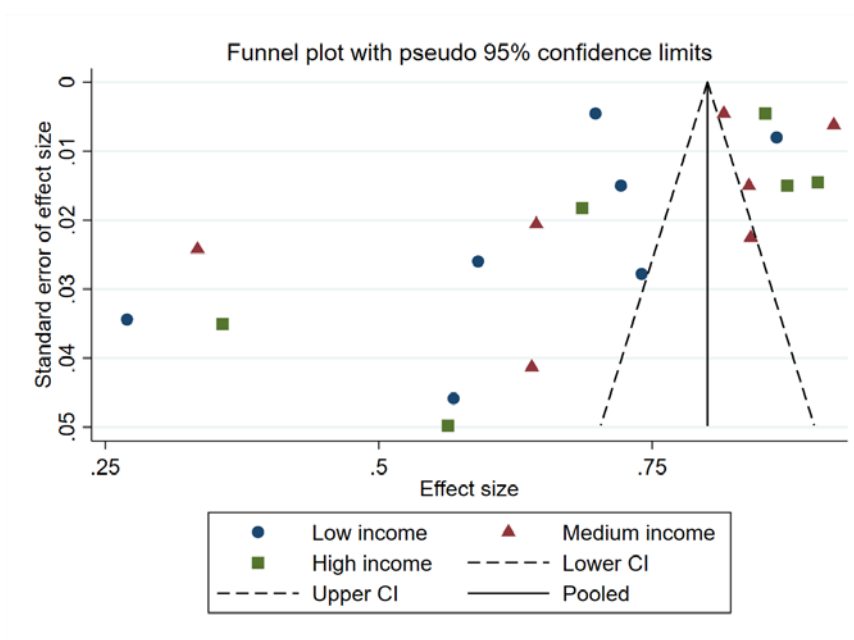


Figure 82. Funnel plot of available income data.

Ethnicity

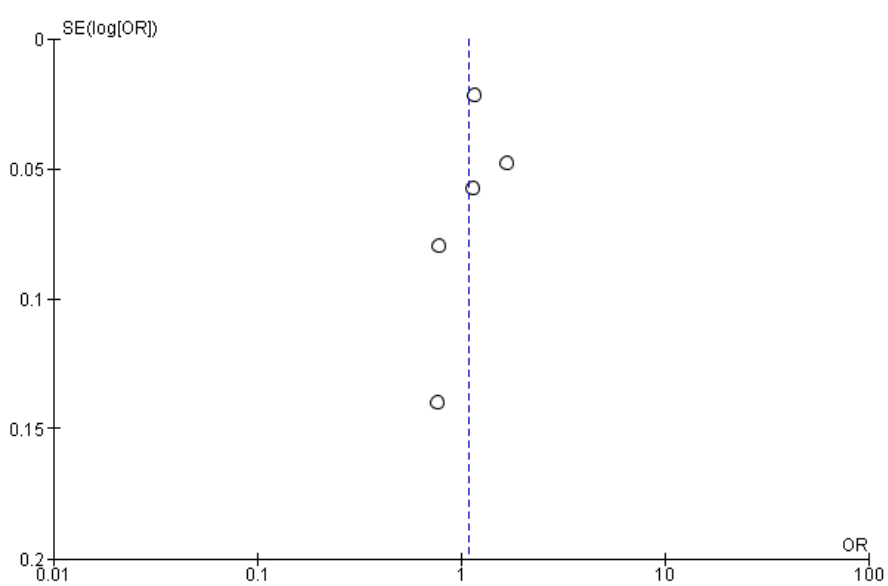


Figure 83. Ethnicity funnel plot conducted on available data.

Housing tenure

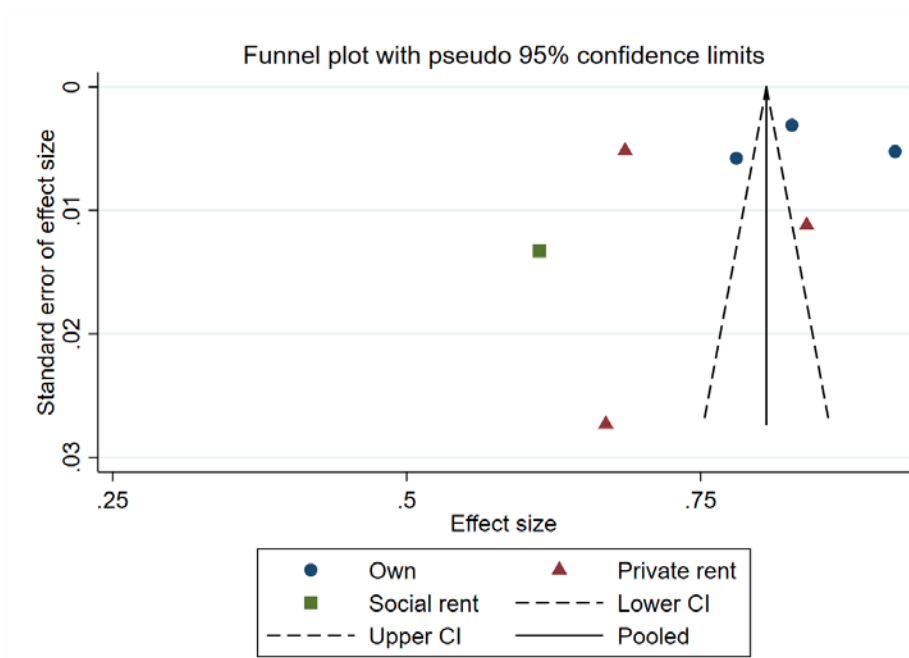


Figure 84. Funnel plot to assess for publication bias within the available housing tenure data

Education

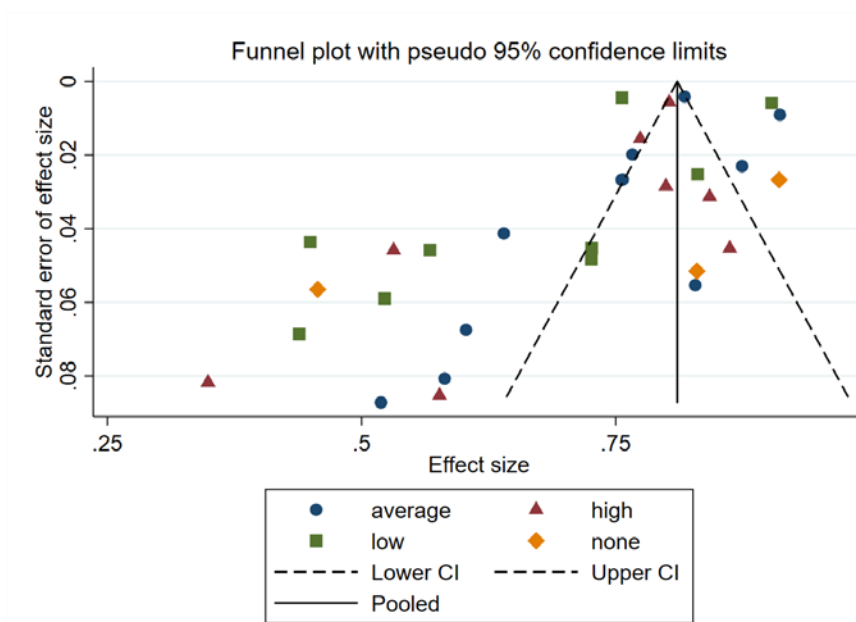


Figure 85. Funnel plot to assess publication bias across available education data.

Insurance

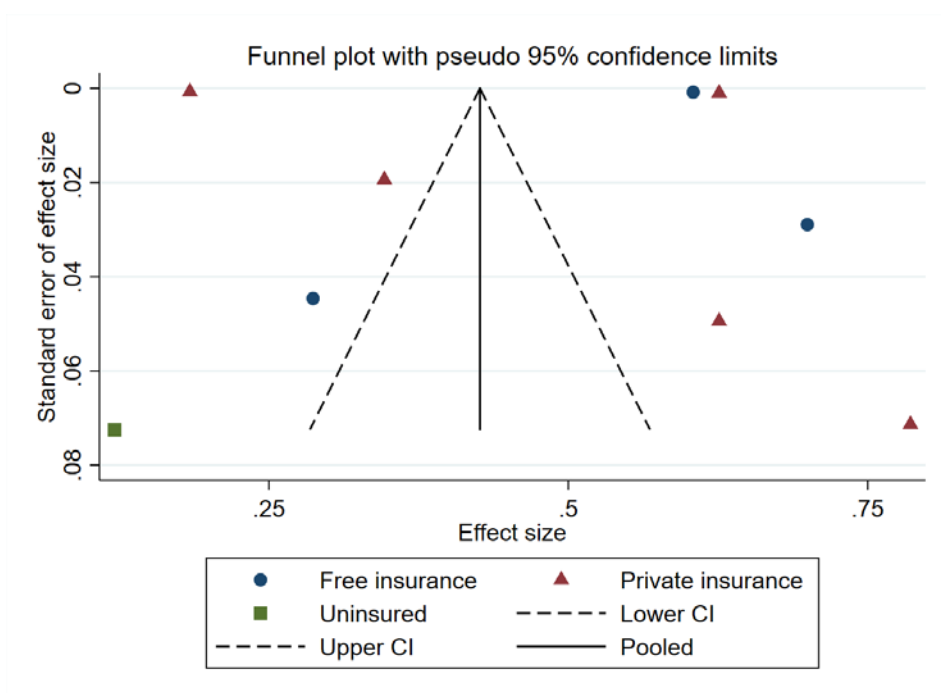


Figure 86. Funnel plot of available insurance data

Chronic conditions

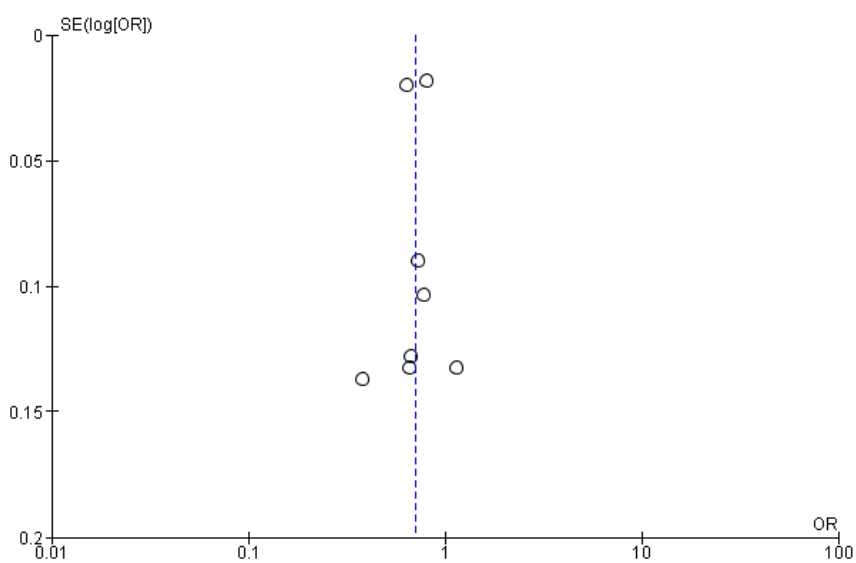


Figure 87. Funnel plot of available chronic conditions data.

8.2 Re-screening data from the Systematic Review

Introduction

In the systematic review, reported in the Chapter 4, data from fifteen re-screening papers were excluded from the main body of the review. These papers were removed from the initial analysis as previous literature has connected outcomes such as attendance at previous attendance and previous false positive results with subsequent re-attendance at BCS (269, 291, 297, 298, 373). However, those fifteen papers provide important information. Once women have attended their first screening appointment they all become re-screening attenders or non-attenders and predictors of their uptake are as important as predictors of uptake at the first appointment. Two predictors in particular are of interest, previous attendance and previous false positive results. Therefore it is important that these are included in the analysis of the review data in order not to bias the results.

8.2.1 Methods

Re-screening refers to any study that used one of the following methods. A study may have analysed a cohort of women who had been previously screened and predictors of their previous screen (such as attendance or false positive result) were used to determine their current uptake or a study may look at adherence or compliance rather than specifically uptake. This frequently occurred in American studies which assessed if women had met the recommendation for screening such as a minimum of two insurance claims made within a three year period. Additionally, studies that investigated patterns of attendance such as which women attended consistently, or intermittently or delayed attendance (attended at the second round rather than at the first invite) were also considered re-screening papers.

The methods used have previously been described see Chapter 4. Both Review Manager 5.3 and Stata 15.1 were used in the meta-analyses of the quantitative data where appropriate. Review Manager was used when there were only two sub-groups. Stata was used where there were three comparison groups such as SES. A narrative synthesis has again been used where insufficient data were available to compare study data.

Analysis is conducted on the fifteen papers that were analysed separately from the systematic review, shown in *Figure 22*.

8.2.2 Results

8.2.2.1 Study characteristics

Of the 91 papers included in the final review, 15 papers were identified relating to rescreening and are presented again below.

Table 31. Re-screening studies identified from the systematic review.

SES=socioeconomic status, †=re-screening data, **=sum to 100% data

Author	Year	Study Design	Study Dates	Geographic area	Number of participants	Predictors Investigated	Summary of main findings as reported in the paper	Ref.
Blanchard†	2004	Retrospective Cohort	Jan 1985 to Feb 2002	United States of America	83511	Previous negative biopsy Ethnicity Insurance	↑re-screening ↑white, ↓hispanic ↑at preferred provider organisation, ↓medicaid	(55)
Chiarelli†	2003	Retrospective Cohort	July 1990 to December 1995	Canada	140723	Age	↑in younger women	(249)
Coyle**†	2014	Retrospective Cohort	April 2001 to October 2004	Northern Ireland	11931	Consistent Age Marital status Housing tenure Car access Education Social class Limiting long-term illness One-time attender Age Marital status	↑with age ↑married ↑owned house ↑with increasing access ↑no education ↑routine ↑if no long-limiting illness	(114)

Author	Year	Study Design	Study Dates	Geographic area	Number of participants	Predictors Investigated	Summary of main findings as reported in the paper	Ref.
						Housing tenure Car access Education Social class Limiting long-term illness	↑with age ↑married ↑owned house ↑with increasing access ↑no education ↑routine ↑if no long-limiting illness	
Fitzpatrick†	2011	Retrospective Cohort	2000 to 2007	Ireland	-	False positive no tissue sampling core biopsy open surgical biopsy TOTAL (all false pos)	Rescreening highest in: ↑age 55-59 ↑age 50-54 ↑age 60-62 ↑age 50-54	(269)
Gregory-Mercado†	2007	Retrospective Cohort	2000 to 2004	United States of America	-	Age Ethnicity	↑rescreening with age ↑re-uptake with American Indian, Alaska natives and white women	(274)
McCann†	2002	Retrospective Cohort	1989-1991	United Kingdom	140387	False positive	↓reattendance if assessed benign rather than assessed normal	(291)
Moss†	2001	Retrospective Cohort	May 1996-	United Kingdom	260914	Age Previous screening history	↑ in younger ↑↑ in those with recent screen (≤5 years)	(295)

Author	Year	Study Design	Study Dates	Geographic area	Number of participants	Predictors Investigated	Summary of main findings as reported in the paper	Ref.
O'Byrne†	2000	Retrospective Cohort	January 1995 to December 1996	Australia	119502	Indigenous status Language spoken at home Location HRT Family history BC Clinic type	↑ non-indigenous ↑ N European ↑ Remote location ↑ in recipients of HRT ↔ no difference ↑ mobile clinics	(141)
Offman†	2013	Randomised Trial	June 2010 to July 2011	United Kingdom	19362	Invite Type Screening unit Previous attendance Age	↑ out of office hours option ↔ variable ↑ attenders ↔ variable	(297)
Oh†	2011	Retrospective Cohort	2005 to 2008	Korea	2511976	Age Insurance Screening results at baseline History of mammogram screening Year	↑ for middle age groups ↑ national health insurance ↑ if negative ↑ if previously screened ↑ in 2006 than 2005	(298)
Pinckney†	2003	Retrospective Cohort	May 1996 to May 1997	United States of America	48538	False positive	↑ in women aged 50+ for both true negative (at 30 months) and false positive	(251)
Tatla†	2003	Retrospective Cohort	January 1995 to December 2000	Canada	57902	Location SES Age	↑ rural ↑ in less affluent ↑ younger women	(255)

Author	Year	Study Design	Study Dates	Geographic area	Number of participants	Predictors Investigated	Summary of main findings as reported in the paper	Ref.
						Language Initial mammography results Previous mammography history Referral by health professional	↑ English ↑ normal previous results ↑ previous attendee ↑ referred by health professional	
Ulcickas†	1999	Retrospective Cohort	1989 to 1996	United States of America	-	Race Age Marital status Income Timing of index mammogram	Rescreening ↑ Caucasian ↓ older women ↑ married women ↑ with higher income ↑ if 1992-1994 index	(169)
von Euler-Chelpin†	2008	Retrospective Cohort	April 1991 to March 1999	Denmark	-	Location Age Civil status Type of citizenship Education	↑ in Funen ↑ younger women ↑ married ↑ non-immigrant ↑ medium education	(320)
Woodhead†	2016	Retrospective Cohort	2012 to 2013	United Kingdom	26010	Mental illness	↓ women with mental health problems ↓↓ bipolar affective disorder	(324)

Table 32. Quality Assessment Summary Table. QAT Rating key: 1 = STRONG = no weak ratings, 2 = MODERATE = one weak rating, 3 = WEAK = two or more weak ratings, NA = withdrawals and dropouts rating not applicable (215).

Author	Year	QAT score
Blanchard†	2004	1
Chiarelli†	2003	1
Coyle**†	2014	1
Fitzpatrick†	2011	1
Gregory-Mercado†	2007	1
McCann†	2002	1
Moss†	2001	1
O'Byrne†	2000	1
Offman†	2013	2
Oh†	2011	1
Pinckney†	2003	1
Tatla†	2003	1
Ulcickas†	1999	1
von Euler-Chelpin†	2008	1
Woodhead†	2016	1

8.2.2.2 False positive

Four studies reported uptake based on prior false positive results (251, 269, 291, 298). There was no significant difference in the odds of re-attendance between women who had or had not previously had a false positive result, OR 0.54 (95% CI 0.08, 3.62). However the finding is heavily influenced by one large study by Oh *et al.* undertaken in 2011 in North Korea which may not be appropriate to combine in this meta-analysis due to the clinical heterogeneity of the national screening programmes.

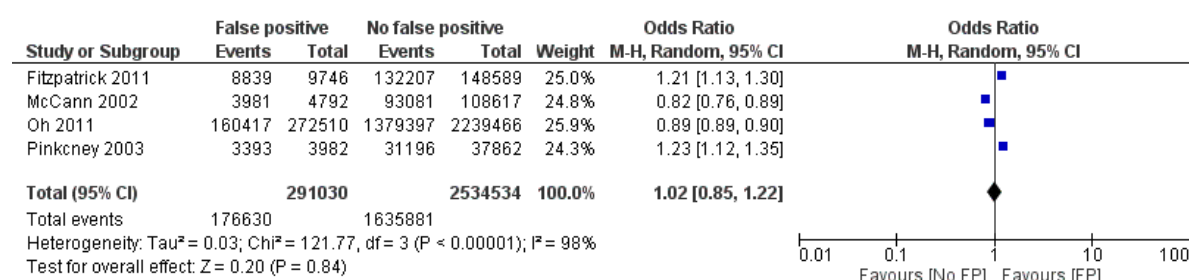


Figure 88. Meta-analysis of available false positive data. FP=false positive.

All of the studies in the above meta-analysis gave significant odds ratio results. However, the combined estimate was not significant.

Pinckney *et al.* assessed the odds of attending in general if a woman had had a false positive index mammogram and found women were 29% more likely to re-attend by 18 months if they

had a false positive result, OR 1.29 (1.20, 1.38) (251). By 30 months, women with a false positive index mammogram were 23% more likely to re-attend, OR 1.23 (1.12, 1.35) (251).

In East Anglia, UK re-attendance was lower for women who had a false positive result. For women who were recalled, assessed and found to be normal odds of re-attending were 16% lower compared with women who were not assessed, OR 0.84 (0.78, 0.92) and for women who were reassessed and diagnosed with a benign breast disease odds of re-attending were 35% lower, OR 0.65 (0.52, 0.81) (291).

Fitzpatrick *et al.* investigated women who previously received false positive results and found the rate of rescreening may be dependent on how invasive the investigation was (269). Furthermore this effect appears to be associated with age as re-attendance was found to be higher in younger age groups. For recalled women who did not undergo tissue sampling, uptake rates were between 90.9% and 91.6% (highest uptake in women aged 50-54 years) (269). For women who had a core biopsy, rescreening rates were lowest for those aged 55-59 years (88.4%) (269). For women who experienced an open surgical biopsy, rescreening rates were lowest (77.9% for women aged 55-59 years) (269). Furthermore, for recalls (except those with no tissue sampling), rescreening was highest in the 50-54 year group (269).

Oh *et al.* also found that compared with women who received a true-negative result, odds of attending for women who received a false-positive result were 11% lower than for women who did not receive a false positive result, OR 0.89 (0.88, 0.90) (298).

Extracted data that could not be combined into the meta-analysis is narratively presented below.

May *et al.* found that if women had previously had a breast biopsy the odds of re-attending BCS were 110% higher compared with women who had not, OR 2.1 (1.2, 3.5) (289). Meguerditchian *et al.* also found odds of re-attending in the next twelve months were 38% higher for women who had had a false positive result, OR 1.38 (1.15, 1.65) (293). However, in Canada the opposite was found to be true. The odds of women attending BCS were 51% lower if they had had a false positive result, OR 0.49 (0.46, 0.52) (255).

To summarise May *et al.* (289) reported a higher rate of attendance for women with previous false positive results at 66.3% (compared to 50.6% for women without previous false positive

results) in 1999. In contrast in 2013, Maxwell et al. (143) reported very slightly lower attendance rates at 90.1% for women with a false positive result compared to 91.1% for women without. The programmes are dissimilar however and there is a fourteen year gap between data which makes the figures difficult to interpret.

In contrast with the meta-analytic findings, higher rates of uptake were found in the younger population (168, 267, 277, 296, 301, 303, 320). This varied for specific groups, for example women experiencing false positive results were more likely to return to screening if they were older 60-62 years (91.0%) compared with woman aged 50-54 years (90.4%) (269). Women returning for re-screening were more likely to be older, 52% of women aged over 60 years attended for re-screening compared with 28% of women aged 40-49 years (274).

8.2.2.3 Previous attendance

Data that could be quantitatively analysed were provided about previous attendance pattern in four papers (255, 295, 297, 298). Results suggest that the odds of reattendance were 6.05 times higher in women who had previously attended BCS than those women who had not, OR 6.05 (1.44, 25.43).

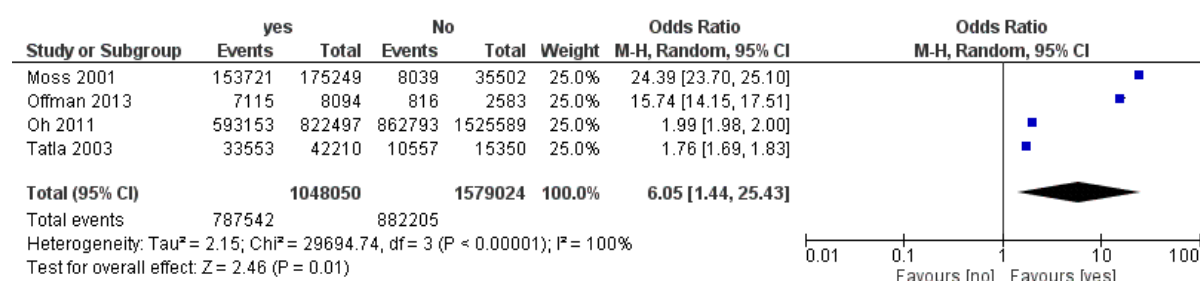


Figure 89. Forest plot of available data for previous attendance

Tatla *et al.* found odds of re-attending were 76% more likely in women who had previously attended BCS (255). Both Oh *et al.* (298) and Moss *et al.* (295) used routine data for their analysis and found women who had previously attended were more likely to re-attend but found very different effect sizes. Offman *et al.* were conducting a randomised trial of weekend or evening appointments and recording effects on attendance. However, for their data analysis any women who needed to rearrange the appointment due to requiring a special appointment (likely due to a disability) was removed from the analysis. This may have increased the likelihood in finding a positive result favouring re-attendance of attenders (297).

Five studies provided data about women's previous attendance at BCS that could not be combined into the meta-analysis (166, 171, 255, 293, 333). Meguerditchian *et al.* found if women had previously attended, their odds of attending were nearly 4 times higher compared with women who had not previously attended, OR 3.94 (3.47, 4.48) (293). In Canada, odds of attending BCS were 76% higher for women who had previously attended mammography compared with those who had not, OR 1.76 (1.69, 1.84) (255). Taylor-Phillips *et al.* found odds of re-attending were 371% higher amongst women who had previously attended BCS compared with those who had not, OR 3.71 (3.49, 4.37) (166). Drosseart *et al.* found that of women who had attended BCS before and invited to re-attend, 94% attended both second and third rounds of screening (333). Vaile *et al.* found of women who had previously attended 74.7% re-attended compared with 87.1% of women who had not previously attended (171).

Meguerditchian *et al.* (293) and Tatla *et al.* (255) both investigated uptake in Canada. Uptake would be expected to be similar across the studies as women can experience similar deterrents to attendance such as vast distances. The lowest reported rates of uptake for women with previous attendance at mammography were found by Meguerditchian *et al.* 60.4% and the highest 79.5% whereas the lowest reported rates of uptake for women without previous attendance were reported by Tatla *et al.* and were 65.2% and the highest 68.8%.

8.2.2.4 SES

Three papers contributed data to the meta-analysis of SES and re-attendance (114, 167, 255). The sub-group meta-analysis showed no significant difference in the proportions re-attending BCS between the SES groups.

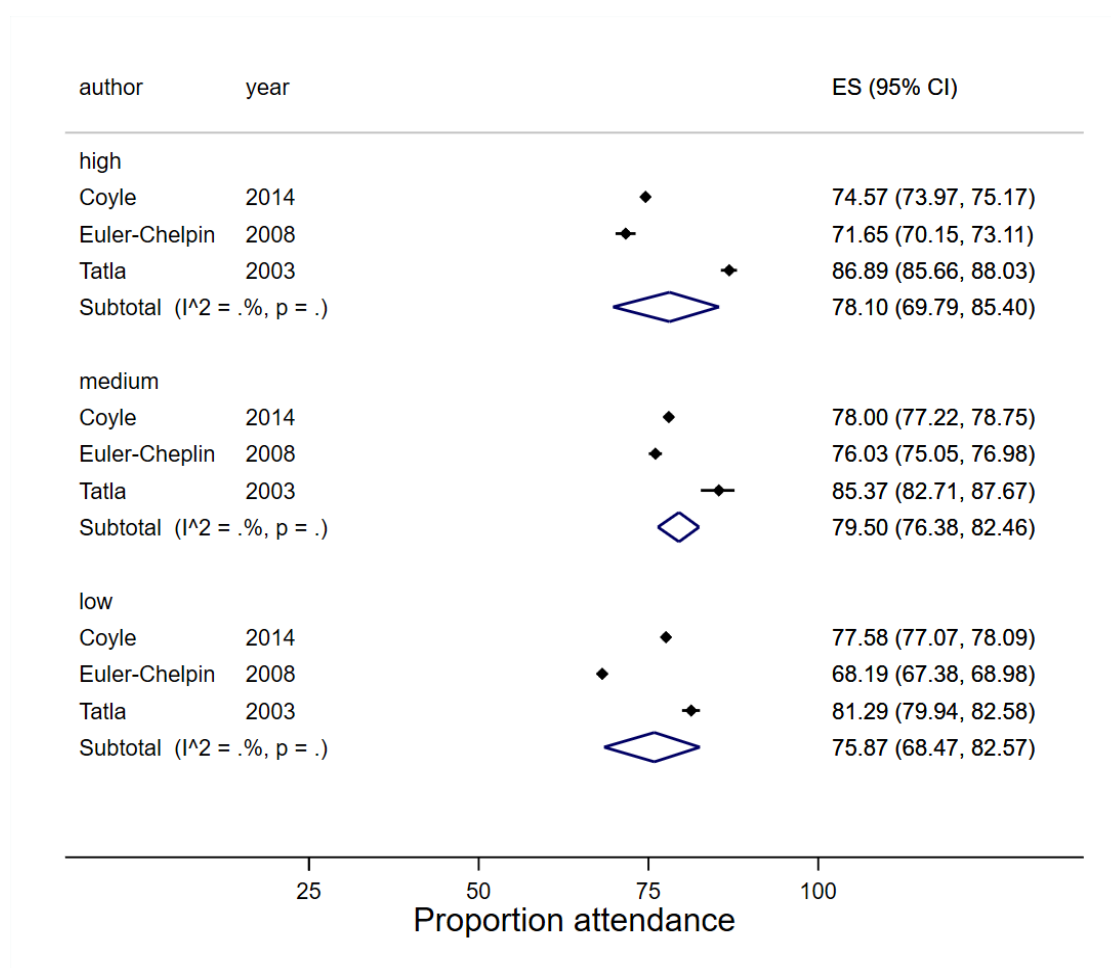


Figure 90. Sub-group meta-analysis of SES data.

Studies reporting SES as employment status are discussed here. Coyle et al. (114) found women who were professional or routine workers were most likely to attend screening regularly (28.2% and 39.2% respectively). Women least likely to attend were self-employed women (114). Euler-Chelpin et al. found women with secretarial or sales careers were most likely to attend all their appointments, 61% in Copenhagen and 79% in Funen (167).

8.2.3 Discussion

8.2.3.1 False positive

No significant difference was found between women who did or who did not have a previous false positive result. This result may suggest that women are not deterred by a previous false positive result although the effect of a false positive result may depend on many different influencing factors. These may include psychosocial aspects such as the level of embarrassment or distress a women may feel about the process or structural factors such as ease of accessing appointments such as car ownership or even perceived risk of BC – a woman

may (wrongly) feel she got away with something last time (447). The type of recall assessment a woman experiences may be important as evidenced by Fitzpatrick *et al.* (269). Despite the difference in age groups, women who underwent tissue sampling, a less invasive procedure, had higher odds of re-attending than women undergoing an open biopsy and their odds of re-attending were found to be not statistically different from women who had a core biopsy (269).

A large sample ($n=5,009,466$) of Korean women were used by Oh *et al.* and they found women with a previous false positive result were much less likely to attend BCS, OR 0.07 (0.07, 0.07) compared with women without a false positive result (298). However, other papers included in this review had much smaller sample sizes and their outcomes were varied. Only one other study found a negative influence on uptake of having a false positive result but a much smaller effect size, OR 0.82 (0.76, 0.89) (291). There were differences between study locations and screening policy. In Korea women were recommended to re-attend in less than three years (Korea's national programme screens women every two years). All studies used retrospective databases to analyse uptake patterns except a study in America by Pinckney *et al.* who followed women prospectively through time to identify their re-attendance rate (251).

Previous research has found mixed results (249, 294, 372, 373, 375, 447) in terms of a possible deterrent effect of previous false positive results. It appears that false positive results may affect women differently. Caution needs to be taken when interpreting the results as the review has included data from Oh *et al.* which may have been too heterogeneous clinically, in terms of the national screening programme, and therefore should have been analysed separately.

8.2.3.2 Previous attendance

This review adds to a body of literature that suggests that women who have previously attended mammography are more likely to attend again. All studies included found that women who had previously attended BCS had higher odds of re-attending than those who had previously not attended, OR 6.05 (1.44, 25.43).

Two studies found extreme odds ratios of fifteen and twenty-four. However, both studies investigated UK data and the only difference was that one was a randomised trial and one was studying routine data. A further study was conducted on a very large sample size of

Korean women, n=5,009,466 who are recommended to be screened more frequently than in the UK. The others investigated previous attendance as a predictor for women in Canada who are also screened biennially.

8.2.3.3 *SES*

No significant difference was found between SES groups and the odds of re-attendance. This is consistent with my systematic review findings for general uptake where no significant difference was found. The women were sampled from Northern Ireland, Denmark and Canada (114, 167, 255) and as such represent very different populations. These distinct populations likely experience different additional facilitators or barriers to attendance as well as other confounding factors associated with uptake of mammography.

Despite this, the result is consistent with other work such as a previous meta-analysis, conducted in 2009, which found mixed yet predominantly positive associations between high SES and re-attendance and concluded that the association may be more complex than anticipated and warrants further research (448). Regardless, SES inequalities in cancer incidence still persist (449).

Conclusions

Data about re-screening attendance has provided statistically significant information about two key predictors for uptake of breast screening. Receiving a false positive result and previously attending mammography have been associated with increased odds of re-attending future BCS. Additional information about socioeconomic status as a predictor of (re)uptake has been evaluated but no significant differences were found in the data available which matches the non-significant findings in the main review results.

In the next chapter I will look at data from a London cohort to identify predictors of uptake in relation to demographic and other factors.

8.3 Secondary data study



Figure 91. SW London catchment area, for reference.

8.3.1 Ethical approvals

8.3.1.1 Sponsorship from University of Warwick



8.3.1.2 BSREC



PRIVATE

Miss R Crosby
WMS
University of Warwick
Coventry
CV4 7AL

20 June 2017

Dear Miss Crosby

Study Title and BSREC Reference: *Patterns of mammography attendance over time (PaMaT)* REGO-2017-2061

Thank you for submitting your revisions to the above-named study to the University of Warwick's Biomedical and Scientific Research Ethics Sub-Committee for approval.

I am pleased to confirm that approval is granted and that your study may commence.

In undertaking your study, you are required to comply with the University of Warwick's *Research Data Management Policy*, details of which may be found on the Research and Impact Services' webpages, under "Codes of Practice & Policies" » "Research Code of Practice" » "Data & Records" » "Research Data Management Policy", at:
http://www2.warwick.ac.uk/services/ris/research_integrity/code_of_practice_and_policies/research_code_of_practice/datacollection_retention/research_data_mgt_policy

You are also required to comply with the University of Warwick's *Information Classification and Handling Procedure*, details of which may be found on the University's Governance webpages, under "Governance" » "Information Security" » "Information Classification and Handling Procedure", at:
<http://www2.warwick.ac.uk/services/gov/informationsecurity/handling>.

Investigators should familiarise themselves with the classifications of information defined therein, and the requirements for the storage and transportation of information within the different classifications:

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<http://www2.warwick.ac.uk/services/gov/informationsecurity/handling/classifications>

Handling Electronic Information:

<http://www2.warwick.ac.uk/services/gov/informationsecurity/handling/electronic/>


Handling Paper or other media

<http://www2.warwick.ac.uk/services/gov/informationsecurity/handling/paper/>.

Please also be aware that BSREC grants **ethical approval** for studies. **The seeking and obtaining of all other necessary approvals is the responsibility of the investigator.**

These other approvals may include, but are not limited to:

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1. Any necessary agreements, approvals, or permissions required in order to comply with the University of Warwick's Financial Regulations and Procedures.
 2. Any necessary approval or permission required in order to comply with the University of Warwick's Quality Management System and Standard Operating Procedures for the governance, acquisition, storage, use, and disposal of human samples for research.
 3. All relevant University, Faculty, and Divisional/Departmental approvals, if an employee or student of the University of Warwick.
 4. Approval from the applicant's academic supervisor and course/module leader (as appropriate), if a student of the University of Warwick.
 5. NHS Trust R&D Management Approval, for research studies undertaken in NHS Trusts.
 6. NHS Trust Clinical Audit Approval, for clinical audit studies undertaken in NHS Trusts.
 7. Approval from Departmental or Divisional Heads, as required under local procedures, within Health and Social Care organisations hosting the study.
 8. Local ethical approval for studies undertaken overseas, or in other HE institutions in the UK.
 9. Approval from Heads (or delegates thereof) of UK Medical Schools, for studies involving medical students as participants.
 10. Permission from Warwick Medical School to access medical students or medical student data for research or evaluation purposes.
 11. NHS Trust Caldicott Guardian Approval, for studies where identifiable data is being transferred outside of the direct clinical care team. Individual NHS Trust procedures vary in their implementation of Caldicott guidance, and local guidance must be sought.
 12. Any other approval required by the institution hosting the study, or by the applicant's employer.

There is no requirement to supply documentary evidence of any of the above to BSREC, but applicants should hold such evidence in their Study Master File for University of Warwick auditing and monitoring purposes. You may be required to supply evidence of any necessary approvals to other University functions, e.g. The Finance Office, Research & Impact Services (RIS), or your Department/School.

May I take this opportunity to wish you success with your study, and to remind you that any Substantial Amendments to your study require approval from BSREC before they may be implemented.

Yours sincerely

pp.

Professor John Davey
Chair
Biomedical and Scientific
Research Ethics Sub-Committee

Biomedical and Scientific
Research Ethics Sub-Committee
Research & Impact Services
University of Warwick
Coventry, CV4 8UW.
E: BSREC@Warwick.ac.uk

[http://www2.warwick.ac.uk/services/
ris/research_integrity/researchethics
committees/biomed](http://www2.warwick.ac.uk/services/ris/research_integrity/researchethicscommittees/biomed)

8.3.1.2 HRA



Health Research Authority

Professor Aileen Clarke
Warwick Medical School, Gibbet Hill Campus
University of Warwick
Coventry
CV4 7AL

Email: hra.approval@nhs.net

16 October 2017

Dear Professor Clarke,

Letter of HRA Approval

Study title:	Patterns of mammography attendance over time
IRAS project ID:	224318
Protocol number:	N/A
REC reference:	17/HRA/3194
Sponsor	University of Warwick

I am pleased to confirm that HRA Approval has been given for the above referenced study, on the basis described in the application form, protocol, supporting documentation and any clarifications noted in this letter.

Participation of NHS Organisations in England

The sponsor should now provide a copy of this letter to all participating NHS organisations in England.

Appendix B provides important information for sponsors and participating NHS organisations in England for arranging and confirming capacity and capability. Please read *Appendix B* carefully, in particular the following sections:

- *Participating NHS organisations in England* – this clarifies the types of participating organisations in the study and whether or not all organisations will be undertaking the same activities
- *Confirmation of capacity and capability* - this confirms whether or not each type of participating NHS organisation in England is expected to give formal confirmation of capacity and capability. Where formal confirmation is not expected, the section also provides details on the time limit given to participating organisations to opt out of the study, or request additional time, before their participation is assumed.
- *Allocation of responsibilities and rights are agreed and documented (4.1 of HRA assessment criteria)* - this provides detail on the form of agreement to be used in the study to confirm capacity and capability, where applicable.

Further information on funding, HR processes, and compliance with HRA criteria and standards is also provided.

IRAS project ID	224318
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It is critical that you involve both the research management function (e.g. R&D office) supporting each organisation and the local research team (where there is one) in setting up your study. Contact details and further information about working with the research management function for each organisation can be accessed from www.hra.nhs.uk/hra-approval.

Appendices

The HRA Approval letter contains the following appendices:

- A – List of documents reviewed during HRA assessment
- B – Summary of HRA assessment

After HRA Approval

The attached document “*After HRA Approval – guidance for sponsors and investigators*” gives detailed guidance on reporting expectations for studies with HRA Approval, including:

- Working with organisations hosting the research
- Registration of Research
- Notifying amendments
- Notifying the end of the study

The HRA website also provides guidance on these topics and is updated in the light of changes in reporting expectations or procedures.

Scope

HRA Approval provides an approval for research involving patients or staff in NHS organisations in England.

If your study involves NHS organisations in other countries in the UK, please contact the relevant national coordinating functions for support and advice. Further information can be found at <http://www.hra.nhs.uk/resources/applying-for-reviews/nhs-hsc-rd-review/>.

If there are participating non-NHS organisations, local agreement should be obtained in accordance with the procedures of the local participating non-NHS organisation.

User Feedback

The Health Research Authority is continually striving to provide a high quality service to all applicants and sponsors. You are invited to give your view of the service you have received and the application procedure. If you wish to make your views known please use the feedback form available on the HRA website: <http://www.hra.nhs.uk/about-the-hra/governance/quality-assurance/>.

HRA Training

We are pleased to welcome researchers and research management staff at our training days – see details at <http://www.hra.nhs.uk/hra-training/>

IRAS project ID	224318
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Your IRAS project ID is **224318**. Please quote this on all correspondence.

Yours sincerely

Aliki Sifostratoudaki
Assessor

Email: hra.approval@nhs.net

Copy to: *Mrs Jane Prewett, University of Warwick, Sponsor Contact*
Ms Sian Ellis, St George's Research Ethics Committee (SGREC), R&D Contact
Miss Rebecca Crosby, University of Warwick, Student

IRAS project ID	224318
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Appendix A - List of Documents

The final document set assessed and approved by HRA Approval is listed below.

Document	Version	Date
Covering letter on headed paper [Covering Letter]		19 May 2017
Evidence of Sponsor insurance or indemnity (non NHS Sponsors only) [Employers Liability Insurance]		22 July 2016
IRAS Application Form [IRAS_Form_14062017]		14 June 2017
Letter from funder [Stipend Status]	1.0	02 March 2016
Letter from sponsor [Sponsorship Confirmation Letter]	1.0	17 March 2017
Letter from statistician [Statistician Approval]	1.0	27 February 2017
Other [Chris Stinton CV]	1.0	25 May 2017
Other [St Georges confirmation no SOA/SOE required]	1.0	17 May 2017
Other [GCP Chris Stinton]	1.0	25 May 2017
Other [GCP Aileen Clarke]	1.0	25 May 2017
Other [GCP Sian Taylor-Phillips]	1.0	25 May 2017
Other [GCP Rebecca Crosby]	1.0	25 May 2017
Referee's report or other scientific critique report [Confirmation of Upgrade to PhD.]	1.0	25 November 2016
Research protocol or project proposal [HRA Sponsorship PaMaT Protocol Patient ID 224318 v3]	3	16 October 2017
Summary CV for Chief Investigator (CI) [Aileen Clarke CV]	1.0	25 May 2017
Summary CV for student [Rebecca Crosby CV]	1.0	25 May 2017
Summary CV for supervisor (student research) [Sian Taylor-Phillips CV]	1.0	25 May 2017

Appendix B - Summary of HRA Assessment

This appendix provides assurance to you, the sponsor and the NHS in England that the study, as reviewed for HRA Approval, is compliant with relevant standards. It also provides information and clarification, where appropriate, to participating NHS organisations in England to assist in assessing and arranging capacity and capability.

For information on how the sponsor should be working with participating NHS organisations in England, please refer to the, *participating NHS organisations, capacity and capability and Allocation of responsibilities and rights are agreed and documented (4.1 of HRA assessment criteria)* sections in this appendix.

The following person is the sponsor contact for the purpose of addressing participating organisation questions relating to the study:

Name: Mrs Jane Prewett
 Tel: 02476522746
 Email: sponsorship@warwick.ac.uk

HRA assessment criteria

Section	HRA Assessment Criteria	Compliant with Standards	Comments
1.1	IRAS application completed correctly	Yes	No comments
2.1	Participant information/consent documents and consent process	Yes	No comments
3.1	Protocol assessment	Yes	No comments
4.1	Allocation of responsibilities and rights are agreed and documented	Yes	The sponsor provided a covering letter stating that St George's does not require the SOA and SOE documents to be completed for single site research not requiring NHS REC review.
4.2	Insurance/indemnity arrangements assessed	Yes	Where applicable, independent contractors (e.g. General Practitioners) should ensure that the professional indemnity provided by their medical defence organisation covers the activities expected of them for this

IRAS project ID	224318
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Section	HRA Assessment Criteria	Compliant with Standards	Comments
			research study
4.3	Financial arrangements assessed	Yes	The study is funded by a PhD studentship. There is no funding available to the site from the sponsor.
5.1	Compliance with the Data Protection Act and data security issues assessed	Yes	<p>The applicant confirmed that only part of the patients' postcode (first 3 or 4) will be extracted and recorded.</p> <p>The applicant confirmed that the person who will be responsible for anonymising the required data, will sent the information to the research team via encrypted email. The anonymised data will be stored on encrypted machines and accessible only by the research team.</p>
5.2	CTIMPS – Arrangements for compliance with the Clinical Trials Regulations assessed	Not Applicable	No comments
5.3	Compliance with any applicable laws or regulations	Yes	No comments
6.1	NHS Research Ethics Committee favourable opinion received for applicable studies	Not Applicable	No comments
6.2	CTIMPS – Clinical Trials Authorisation (CTA) letter received	Not Applicable	No comments
6.3	Devices – MHRA notice of no objection received	Not Applicable	No comments
6.4	Other regulatory approvals and authorisations received	Not Applicable	No comments

Participating NHS Organisations in England

This provides detail on the types of participating NHS organisations in the study and a statement as to whether the activities at all organisations are the same or different.

This is a single site study where the site is responsible for all activities as stated in the protocol.

The Chief Investigator or sponsor should share relevant study documents with participating NHS organisations in England in order to put arrangements in place to deliver the study. The documents should be sent to both the local study team, where applicable, and the office providing the research management function at the participating organisation. For NIHR CRN Portfolio studies, the Local LCRN contact should also be copied into this correspondence. For further guidance on working with participating NHS organisations please see the HRA website.

If chief investigators, sponsors or principal investigators are asked to complete site level forms for participating NHS organisations in England which are not provided in IRAS or on the HRA website, the chief investigator, sponsor or principal investigator should notify the HRA immediately at hra.approval@nhs.net. The HRA will work with these organisations to achieve a consistent approach to information provision.

Confirmation of Capacity and Capability

This describes whether formal confirmation of capacity and capability is expected from participating NHS organisations in England.

Participating NHS organisations in England will be expected to formally confirm their capacity and capability to host this research.

- Following issue of this letter, participating NHS organisations in England may now confirm to the sponsor their capacity and capability to host this research, when ready to do so. How capacity and capability will be confirmed is detailed in the *Allocation of responsibilities and rights are agreed and documented (4.1 of HRA assessment criteria)* section of this appendix.
- The [Assessing, Arranging, and Confirming](#) document on the HRA website provides further information for the sponsor and NHS organisations on assessing, arranging and confirming capacity and capability.

Principal Investigator Suitability

This confirms whether the sponsor position on whether a PI, LC or neither should be in place is correct for each type of participating NHS organisation in England and the minimum expectations for education, training and experience that PIs should meet (where applicable).

A Principal Investigator (PI) would be expected at this site type. A PI has already been identified as Dr Wilkinson.

GCP training is not a generic training expectation, in line with the [HRA statement on training expectations](#).

HR Good Practice Resource Pack Expectations

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This confirms the HR Good Practice Resource Pack expectations for the study and the pre-engagement checks that should and should not be undertaken

The study activities (anonymizing of the required data) which will be undertaken at the NHS site will involve NHS staff, therefore HR arrangements are not required.

Other Information to Aid Study Set-up

This details any other information that may be helpful to sponsors and participating NHS organisations in England to aid study set-up.

The applicant has indicated that they do not intend to apply for inclusion on the NIHR CRN Portfolio.

8.3.1.3 R&D

“ Dear Rebecca,

RE: IRAS 224318 - Confirmation of Capacity and Capability at St George’ University Hospitals NHS Foundation Trust

Full Study Title:	Patterns of Mammography attendance over time (PaMaT)
Site PI/LC	Dr Louise Wilkinson
Current Protocol version:	V3 16/10/2017
Latest HRA Approval date:	16/10/2017

This email confirms that **St George’s University Hospitals NHS Foundation Trust** has the capacity and capability to deliver the above referenced study. As per the HRA approval letter dated 16/10/2017, neither St. George’s nor Warwick University required the statement of activities or schedule of events in this instance.

St George’s University Hospitals NHS Foundation Trust agrees to start this study on **23/10/2017**.

If you wish to discuss further, please do not hesitate to contact us and local team.

Please note, in line with the national HRA approvals process, you will no longer receive a NHS R&D Approval/Permission letter.

Kind regards,

Siân Ellis

Research Ethics Officer

Joint Research and Enterprise Office

St George's, University of London and St. George’s University Hospitals NHS Foundation Trust

Cranmer Terrace, London, SW17 0RE

Tel: 0208 266 6073

sellis@sgul.ac.uk “

 Reply
  Reply All
  Forward


 Tue 17/10/2017 10:28
 Sian Ellis <sellis@sgul.ac.uk>
 IRAS 224318 - Confirmation of Capacity and Capability at St Georges Healthcare NHS Foundation Trust

To: Cindy, Rebecca; Sponsorship Resources; Clarke, Allen
 Cc: Louise Wilkinson; Sue Hudson

Dear Rebecca,

RE: IRAS 224318 - Confirmation of Capacity and Capability at St George's University Hospitals NHS Foundation Trust

Full Study Title:	Patterns of Mammography attendance over time (PAMA3)
Site PI/IC:	Dr Louise Wilkinson
Current Protocol version:	V3 16/10/2017
Latest HRA Approval date:	16/10/2017

This email confirms that St George's University Hospitals NHS Foundation Trust has the capacity and capability to deliver the above referenced study. As per the HRA approval letter dated 16/10/2017, neither St. George's nor Warwick University required the statement of activities or schedule of events in this instance.

St George's University Hospitals NHS Foundation Trust agrees to start this study on 23/10/2017.

If you wish to discuss further, please do not hesitate to contact us and local team.

Please note, in line with the national HRA approvals process, you will no longer receive a NHS R&D Approval/Permission letter.

Kind regards,

Sian Ellis
 Research Ethics Officer
 Joint Research and Enterprise Office
 St George's, University of London and St. George's University Hospitals NHS Foundation Trust
 Cranmer Terrace, London, SW17 0RE

Tel: 0208 266 6073
sellis@sgul.ac.uk

8.3.2 Summary of data

Episodes and appointments data that was inconsistently matched prior to 2000 which was subsequently removed from the analysis.

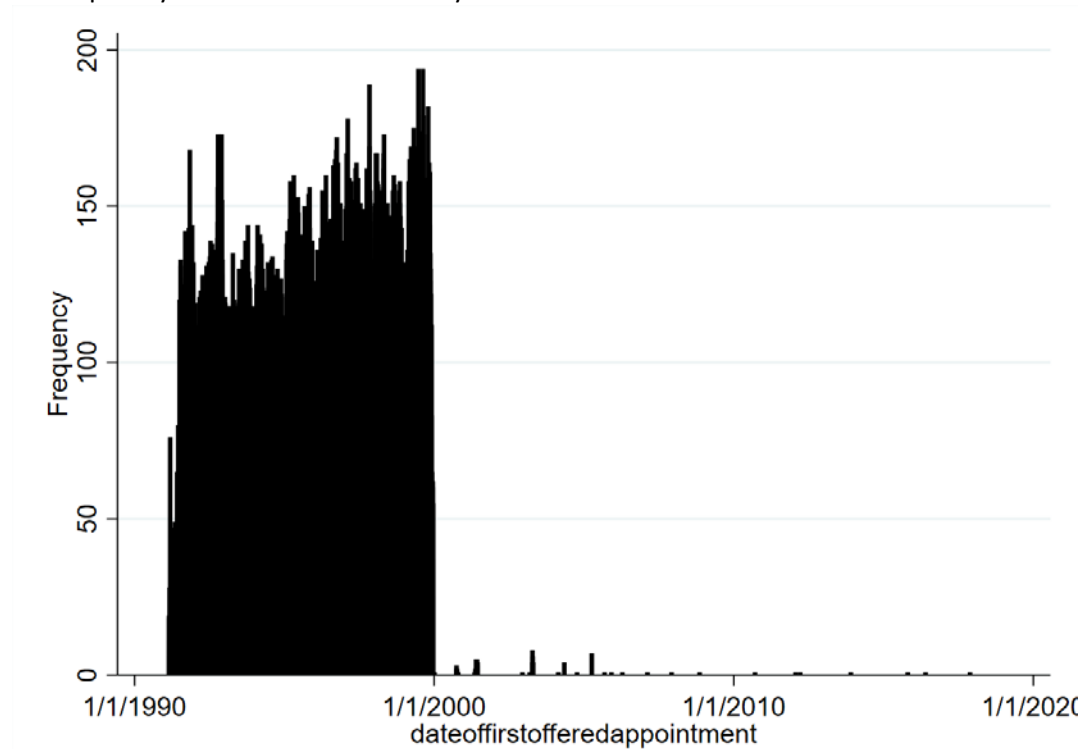


Figure 92. Episodes data without appointments ($n=345,301$). This is data that matches episodes with women, however there are no appointments that match. In order to attend the breast screening service a women must have an appointment within an episode.

8.3.3 Data linkage schematic



Figure 93. Data linkage schematic

8.3.4 Variable summaries

Table 33. Number of observations within each separate database and the combined final database

Variable	Number in raw database	Number in combined database
Women	406,015	336,717
Episodes	1,283,671	1,013,928
Appointments	1,521,309	1,109,034

Table 34. Variable summary table. This summary is for the raw, uncombined datasets.

Name of Variable (original, renamed and de-stringed)	What information does the variable provide?	Plausible values provided as (vertically) range	Frequency of each outcome where appropriate (initially)	Values that agree with other records	How many meet the criteria	Missing data	Next action
Episodes							
NhsNumberCryptic nhscryptic	Anonymised unique identifier	Nxxx values A-Z and 2-9		Should match with episode and appointments data		0	Nothing
EpisodeRecordId episodeid	Sequential episode number to link to other information			Should match with appointmentdata		0	Nothing
AssociatedGpFullCode gpcode	Registered GP	AAA/GGGG				0	Nothing
AgeAtFoa ageatfoa	Age at the first offered appointment within an episode	47 To 73 (Out of range)	4090	Check correct by:(datefirstappt)-(yob)=ageatfoa	1223660	55921	Drop data if not aged 47-73

Name of Variable (original, renamed and de-stringed)	What information does the variable provide?	Plausible values provided as (vertically)	Frequency of each outcome where appropriate (initially)	Values that agree with other records	How many meet the criteria	Missing data	Next action
DateOfFirstOfferedAppointment datefirstappt	Date of the first appointment within an episode	DATE (jan 1991 onwards)		This should be BEFORE dateapptmade	1228380	55291	Nothing
DateApptFirstMade dateapptmade	Date the first appointment within an episode was made	DATE (jan 1991 onwards)		This should be BEFORE dateclinic	1229407	54264	Nothing
EpisodeCharacter episodecharacter	Whether the screen was the first screening or a routine recall	CA = continued assessment CD = delayed treatment CF = follow-up after treatment CI = interval case CR = local recurrence F = first call G = GP referral H = higher risk N = non-routine recall R = routine recall S = self-referral X = other	F = 566707 R = 716964	Values should only be F or R. Values should match with pistatus below	1283671	0	Nothing
PrevalentIncidentStatus pistatus	Whether the episode was the incident or prevalent screen	I = incident P = prevalent XI = xincident XP = xprevalent	566550 219001 191277 306843	Values should match with episodecharacter above	1283671	0	Nothing

Name of Variable (original, renamed and de-stringed)	What information does the variable provide?	Plausible values provided as (vertically)	Frequency of each outcome where appropriate (initially)	Values that agree with other records	How many meet the criteria	Missing data	Next action
EpisodesClosed episodeclosed	Is the episode (screening round) still ongoing for this woman?	Y N	1261389 22282		1283671	0	Nothing
ReasonEpisodeClosed episodeclosed	What was the reason for the episode closure.	AR = randomised out BS = being screened CP = under care, perm CT = under care, temp DD = died DE = defaulted DU = further details unavailable FB = FPC closed, being sx FC = FPC closed, ceased FD = FPC closed, died FF = FPC closed, FP69 FM = FPC closed, moved FP = FPC closed, prem FX = FPC closed, other HR = MV = moved away NA = non-attender NK = not known at address	24948 1553 136 13919 628 328 38 8216 1394 75 8166 513 25 893 77 2226 293497 9106 11 3159 5 821	If DD or FD, woman should not be present in database again.	1283671	0	Nothing

Name of Variable (original, renamed and de-stringed)	What information does the variable provide?	Plausible values provided as range (vertically)	Frequency of each outcome where appropriate (initially)	Values that agree with records	How many meet the criteria	Missing data	Next action
		NR = non-responder NS = attended not screened NT = no transport to unit OP = opted out, permanent OT = opted out, temporary R = routine closure RS = recently screened X = other Blank	77171 782597 32028 858 22283				
AttendedAppointment attendappt	Did the woman attend the appointment?	Y = attended an appointment in this episode N = otherwise	598754 684917		1283671	0	Nothing
EpisodeAuthorityEndCode episodeendcode	What was the reason for the closure of the appointment?	BLANK if episode is open DNA = did not attend DNR = did not respond PC = premature closure SC = screening complete WB = withdrawn - being screened	22283 293563 11 103405 785183 7216 1394 75 19485		1283671	0	Nothing

Name of Variable (original, renamed and de-stringed)	What information does the variable provide?	Plausible values provided as (vertically)	Frequency of each outcome where appropriate (initially)	Values that agree with other records	How many meet the criteria	Missing data	Next action
		WC = withdrawn – ceased WD = withdrawn – died WF = withdrawn – FP69 WM = withdrawn – moved WO = withdrawn – other WS = withdrawn – suspended	513 25595 24948				
EpisodeEndPoint episodeend	The series of events that happened in the episode.	Procedure outcomes separated by commas, for example “S+,Aabn,H-”		Blank is not screened or episode is still open. S- = screen negative S+ = screen positive (and recalled) Sabn = screen abnormal W = core biopsy outcome (+-abn) C = fine needle cytology outcome (+-abn)		498528	Nothing we can do about it.

Name of Variable (original, renamed and de-stringed)	What information does the variable provide?	Plausible values provided as (vertically)	Frequency of each outcome where appropriate (initially)	Values that agree with other records	How many meet the criteria	Missing data	Next action
				H = surgical outcome (+-abn)			
FinalActionInEpisodeTxt finalactionepisode	Final action in episode	Early clinic Follow-up Medical treatment No action Routine recall Blank	2952 6026 69 3 775681 498940		1283671	0	Nothing
CancerRegistryCandidate cancerregistry	Was the woman registered as a cancer patient?	Y N	6386 1277285		1283671	0	Nothing
<u>Appointments</u>							
AppointmentNumber apptnr	Sequential appointment number (general)	1 2 3 4 5 ... 201	982919 270364 61569 22580 12802 ... 1	Numeric sequence with DATE	1521309	0	Nothing
ScreeningAppointmentNumber screenapptnr	Indicates sequential appointment number within episode. Left blank for cancelled appointments	1 2 3 4 5 6	922528 113563 3960 221 17 1	Numeric sequence with DATE	1040290	481019	Nothing we can do about it

Name of Variable (original, renamed and de-stringed)	What information does the variable provide?	Plausible values provided as (vertically)	Frequency of each outcome where appropriate (initially)	Values that agree with other records	How many meet the criteria	Missing data	Next action
	or assessment appointments						
ClinicCode clinic	Which clinic did the woman attend?	ZZ111 (variable)			1521309	0	Nothing
DateOfClinic dateclinic	On what date did the woman attend?	DATE (Jan 1991 onwards)		Should be after datefirstappt and dateapptmade	1521309	0	Nothing
Timeslot timeclinic	At what time did the clinic run?	0800 etc		Should be between 0815 and 1945	1521309	0	Nothing
AppointmentStatus apptstatus	Appointment status	A = attended B = booked D = DNA - no notice given N = DNA - notice given by client	661717 8586 370054 480952		1521309	0	Nothing
CancellationType canceltype	Cancellation information (where given)	Blank AW = adverse weather DE = declined EA = equipment availability HO = holiday IC = inconvenient ME =	1040358 914 19350 702 19474 160810 2627	If N in apptstatus	1521309	0	Nothing

Name of Variable (original, renamed and de-stringed)	What information does the variable provide?	Plausible values provided as range (vertically)	Frequency of each outcome where appropriate (initially)	Values that agree with records	How many meet the criteria	Missing data	Next action
		moving/emigrating PP = postal problems RL = RS = recently screened SI = sickness ST = staffing issues TA = transport/accessibility UC = WC = work commitments ZO = other Blank	815 41 17638 10568 401 6534 8477 23684 208916				
BookingOrCancelDate bookcanceldate	Date at which woman booked or cancelled the appointment	DATE (Jan 1991 onwards)			1521309	0	Nothing
NotScreened notscreened	Was the woman not screened	Y (if attended but not screened) N (if screened) Blank (if screened as normal)	2732 835554 683032		1521309	0	Nothing
NotScreenedComment notscreenedcomment	More information (qualitative) about woman	Qualitative data was entered			1521309	0	Nothing

Name of Variable (original, renamed and de-stringed)	What information does the variable provide?	Plausible values range (vertically)	Frequency of each outcome where appropriate (initially)	Values that agree with other records	How many meet the criteria	Missing data	Next action
	not being screened						
Women							
GpFullCode gpcode	GP woman registered to	Variable			405829	186	Nothing
EthnicOriginText ethnicity	Ethnicity as self-reported	Asian or Asian British – Bangladeshi Asian or Asian British – Indian Asian or Asian British – Pakistani Asian or Asian British – Other Black or Black British – African Black or Black British – Caribbean Black - Other Mixed – White and Asian Mixed – White and Black Mixed – White and Caribbean Mixed - Other Other ethnic groups - Chinese White – British	489 6897 2446 6025 5949 8417 620 1038 551 952 927 2282	This should not change over time	185113	220902	Nothing

Name of Variable (original, renamed and de-stringed)	What information does the variable provide?	Plausible values provided as (vertically)	Frequency of each outcome where appropriate (initially)	Values that agree with other records	How many meet the criteria	Missing data	Next action
		White – Irish White – Other Other Not stated Blank	113001 4694 13055 1991 15779 220902				
EthnicOriginTextOld ethnicold	Not used anymore. To be deleted.		NO OBSERVATIONS!!				DELETE
SpecialAppointmentIndicator specialappt	Did the woman require additional help to the appointment	Y N Blank	18236 3126 384653		406015	0	Nothing
SpecialAppointmentReasons specialreason	What was the reason given for needing the special appointment	Agoraphobia Implants Learning difficulties Physical restrictions Registered disabled Social reasons Wheelchair user Other			Qualitative data		Nothing
CallRecallStatus callrecall	Was the woman placed on the recall status list	C = ceased N = normal	1047 404967	If N, check woman is entered in three years?	406014	1	Nothing
YOB yob	Year of birth	1900 ... 2013	Should not change	YOB should only be from 1918 to	406015	0	Will drop any

Name of Variable (original, renamed and de-stringed)	What information does the variable provide?	Plausible values provided as (vertically)	values range	Frequency of each outcome where appropriate (initially)	Values that agree with other records	How many meet the criteria	Missing data	Next action
					1970			that are <1918 and >1970
LSOAcodes Isoacode	Data used for IMD					406015	0	Nothing
LSOAnames Isoaname	Date used for IMD					406015	0	Nothing
IndexOfMultipleDeprivationRank imdrank	Rank of IMD	1 To 32844				406015	0	Nothing
IndexOfMultipleDeprivationDecile imddecile	IMD information provided for SES Use IMD at first appointment	1 2 3 4 5 6 7 8 9 10 N/A		11090 84247 103545 145407 116147 158929 144122 177413 251987 159817 2436		398665	7350	Nothing

Table 35. Additional variables used in the dataset

Variable name	What information does it provide	Possible values	Frequency of values	Missing data?
attendedonce	Attended at least once per episode/screening round	1 0	598717 415211	
attendfirstapptepisode	Attended at the first appointment within each episode	1 0	374744 639184	
Changeattend (attend to not attend)	Change in attendance (either used to attend and now didn't or previously non-attender and now attends)	1 0	364832 649096	
Changeattend (not attend to attend)	Change in attendance (either used to attend and now didn't or previously non-attender and now attends)	1 0	223973 789955	
prevfalsepos	Previously had a false positive diagnosis of breast cancer	1 0	4662 1009266	
recallattend	Recalled for assessment and attended	1 0	1783 1012145	
recalldna	Recalled for assessment and did not attend	1 0	1012145 1783	
preveprecall	Woman has previously been recalled for further assessment at a previous episode	1 0	307,529 618,528	

Variable name	What information does it provide	Possible values	Frequency of values	Missing data?
Immediateprevrecalepisode	The episode before woman was recalled for further assessment	1 0	833 925,224	
Attended appointment 1		1	598749	0
Did not attend appointment 1		0	415179	
Attended appointment 2		1	257014	652557
Did not attend appointment 2		0	104357	
Attended appointment 3		1	45994	959583
Did not attend appointment 3		0	8351	
Attended appointment 4		1	10030	1001791
Did not attend appointment 4		0	2107	
Attended appointment 5		1	2290	1011023
Did not attend appointment 5		0	615	
Attended appointment 6		1	530	1013203
Did not attend appointment 6		0	195	
Attended appointment 7		1	159	1013694
Did not attend appointment 7		0	75	
Attended appointment 8		1	44	1013860
Did not attend appointment 8		0	24	
Attended appointment 9		1	16	1013902
Did not attend appointment 9		0	10	
Attended appointment 10		1	7	1013919
Did not attend appointment 10		0	2	
Attended appointment 11		1	2	1013926
Did not attend appointment 11		0	0	
Attended appointment 12		1	1	1013927
Did not attend appointment 12		0	0	

8.3.5 Descriptive statistics

8.3.5.1 Number of appointments within each episode

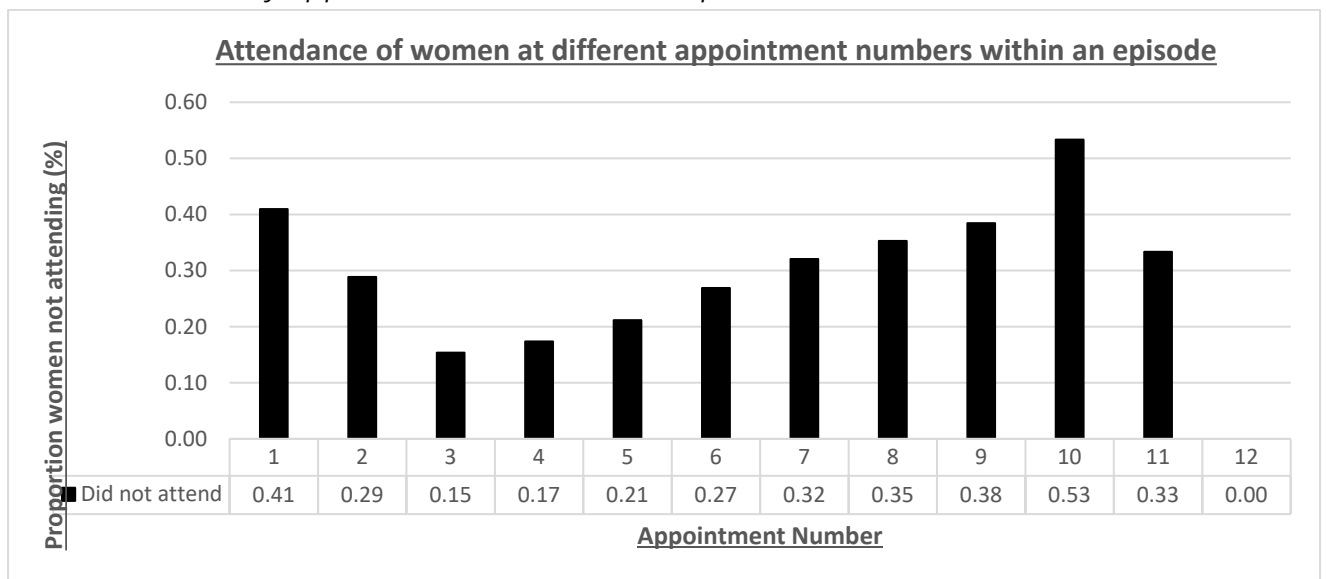


Figure 94. The graph depicts women's percentage of attendance at different chronological appointment numbers within an episode.

8.3.5.2 Age

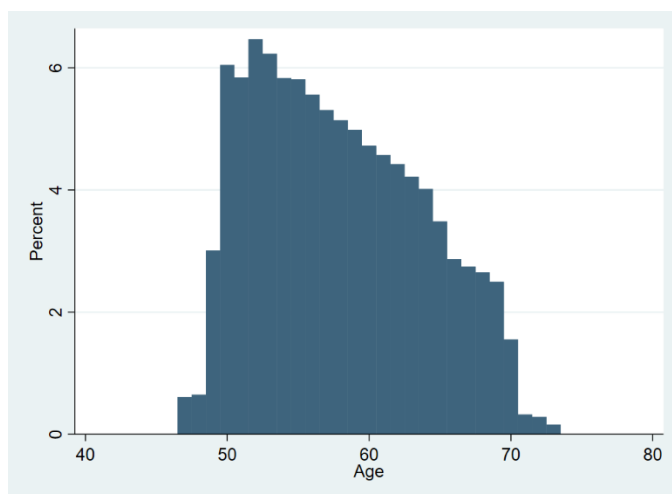


Figure 95. Distribution of women's ages for the entire dataset

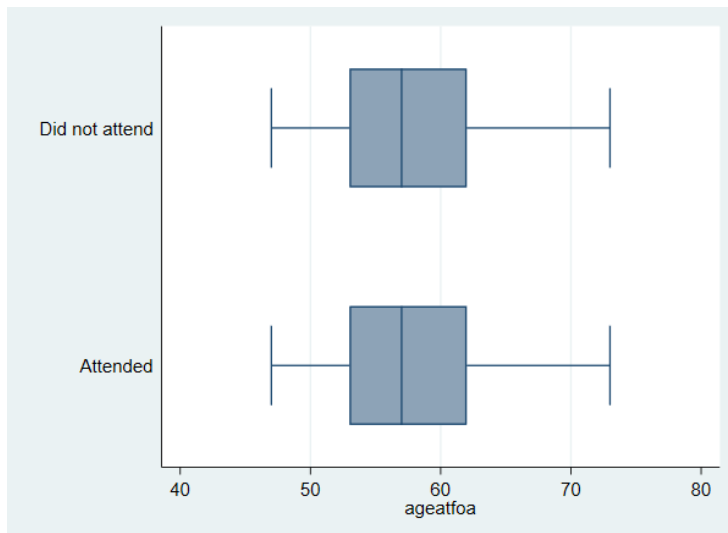


Figure 96. Box plot showing distribution of age separated by attendance status

Table 36. Number of women who did and did not attend sorted by age category

Age category	Number of women	Number attended	Number did not attend	Percent attended (per group)
47-50	102598	58931	43667	57.44
51-55	305668	177678	127990	58.13
56-60	261952	154591	107361	59.02
61-65	215831	126558	89273	58.64
66-70	117986	75290	42696	63.81
71-73	6872	4231	2641	61.57

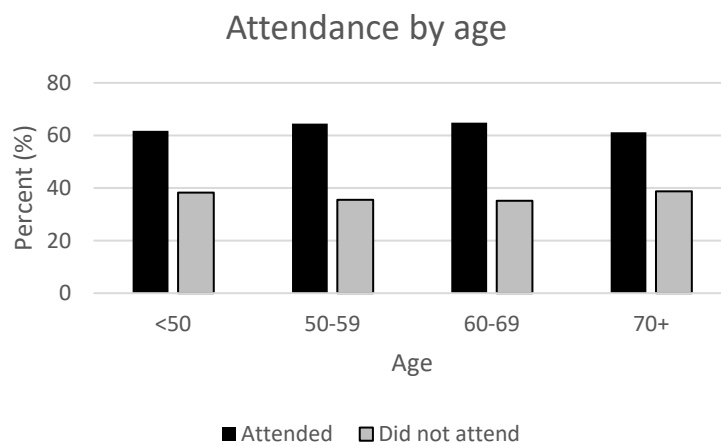


Figure 97. Number of episodes attended by age group.

8.3.5.3 IMD

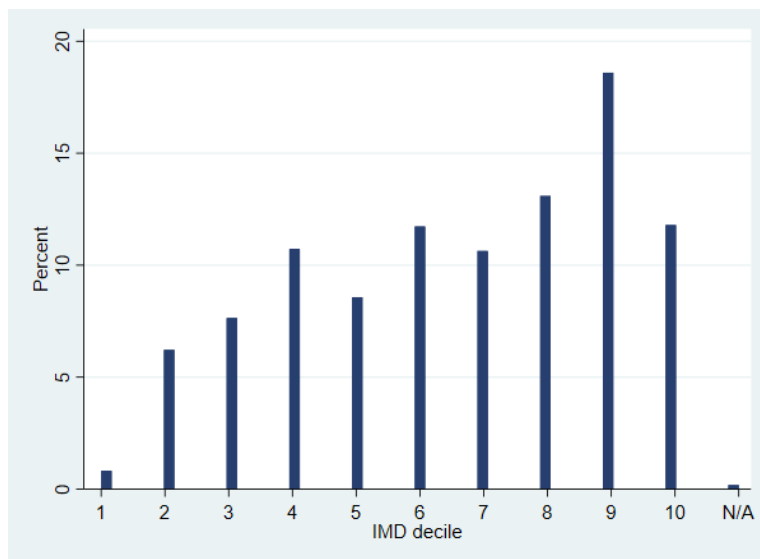


Figure 98. Distribution of deprivation of all women included in the dataset. IMD=1 is most deprived, IMD=10 is least deprived, IMD=N/A is data missing

Table 37. Raw number of women attending and not attending by IMD decile with attributed percentages

IMD decile	Number Attended	IMD compilation of attending women (%)	Number not attended	IMD compilation of non-attending women (%)	Percent attended (per IMD decile)
1 (most deprived)	6355	0.70	4735	1.07	57.30
2	49606	5.44	34641	7.81	58.88
3	92407	6.85	41138	9.28	69.20
4	91116	9.99	54291	12.24	62.66
5	75555	8.29	40592	9.15	65.05
6	106679	11.70	52250	11.78	67.12
7	97707	10.72	46415	10.47	67.79
8	124018	13.60	53395	12.04	69.90
9	180306	19.78	71681	16.16	71.55
10 (least deprived)	116449	12.77	43368	9.78	72.86
N/A	1427	0.16	1009	0.23	58.58

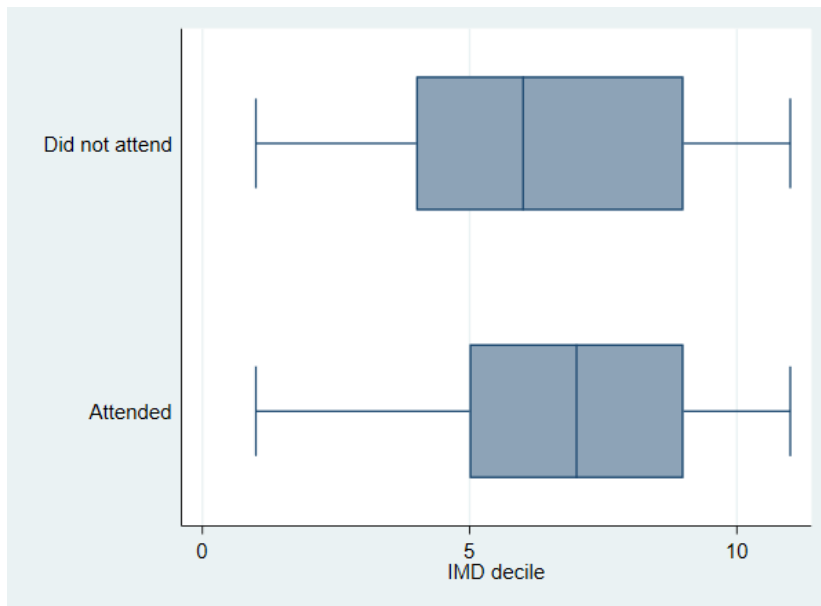


Figure 99. Box plot showing distribution of IMD separated by attendance status

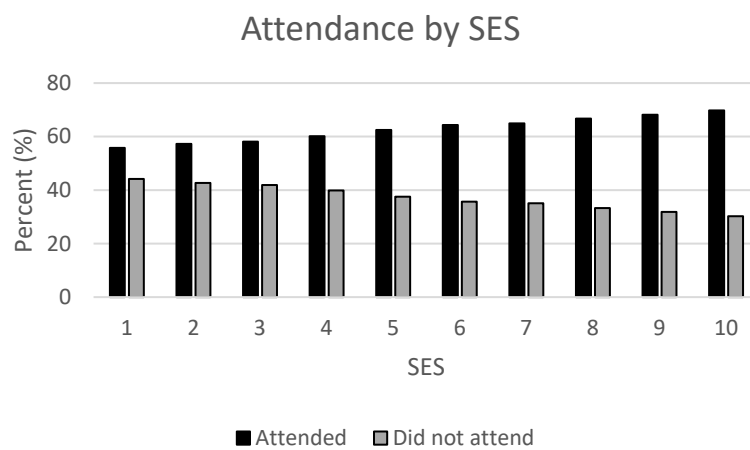


Figure 100. Number of episodes attended by SES group.

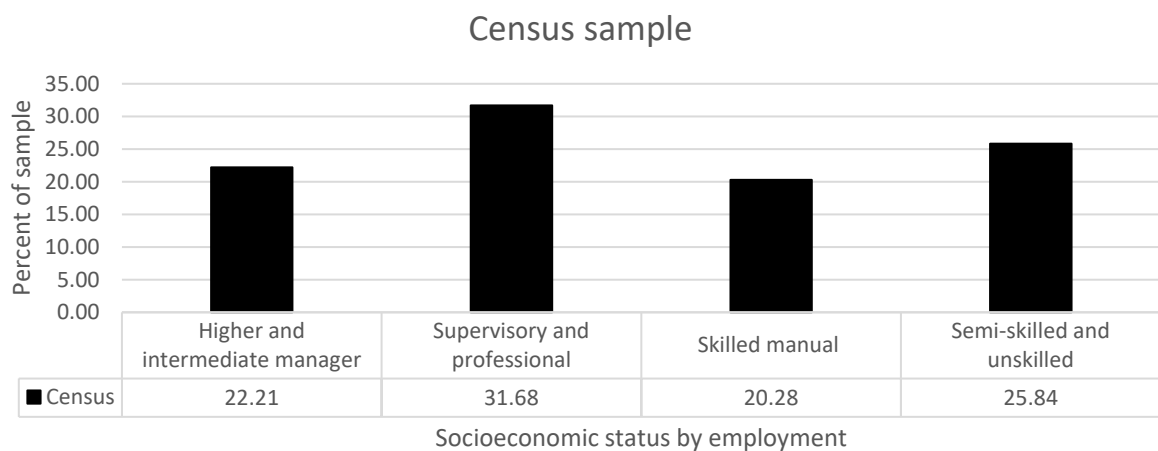


Figure 101. Socioeconomic composition of England using Census data (2014).

8.3.5.4 Ethnicity

Table 38. Number and percent of missing ethnicity data per age group.

Age group	Number missing	% missing (per age group)
47-50	57842	38.76
51-55	139817	31.89
56-60	103225	27.61
61-65	94445	31.24
66-70	41640	24.93
71-73	2382	22.94
TOTAL	439351	

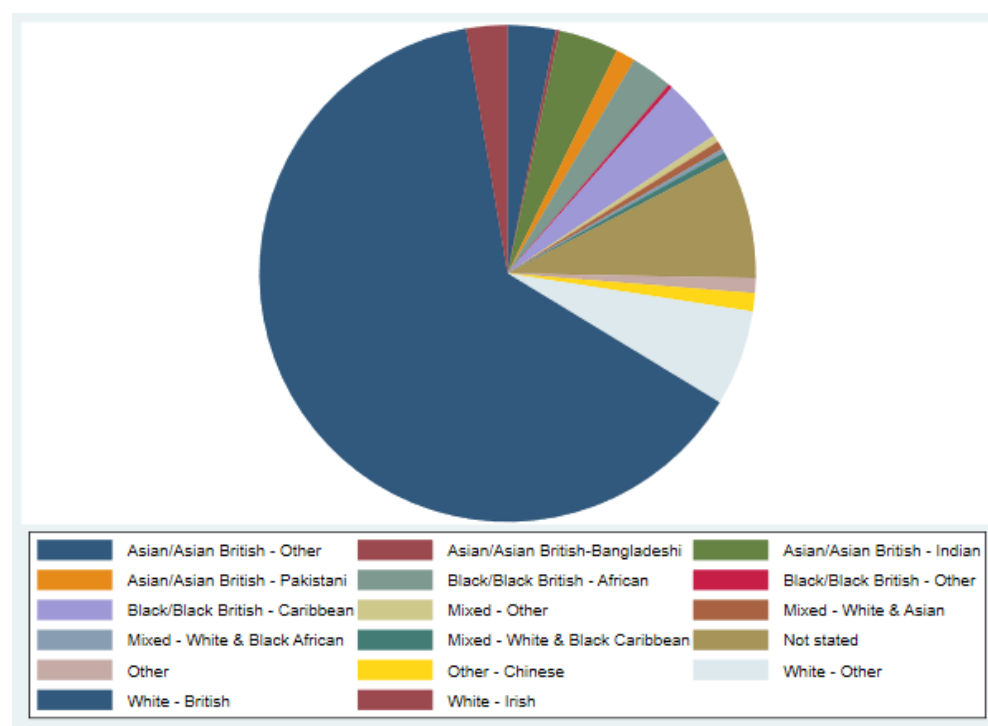


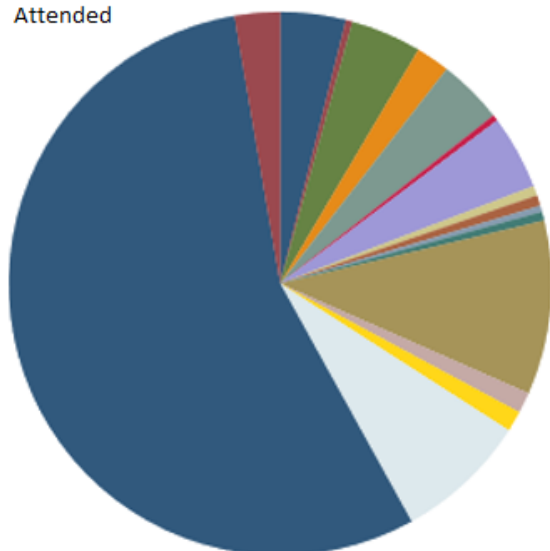
Figure 102. Distribution of all ethnicities reported in database

Table 39. Number of women who did and did not attend by ethnicity

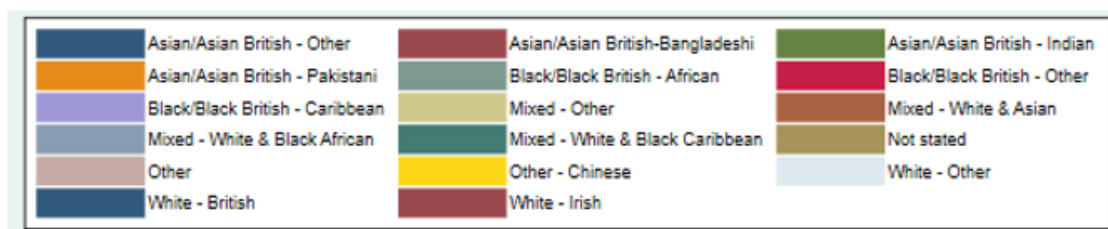
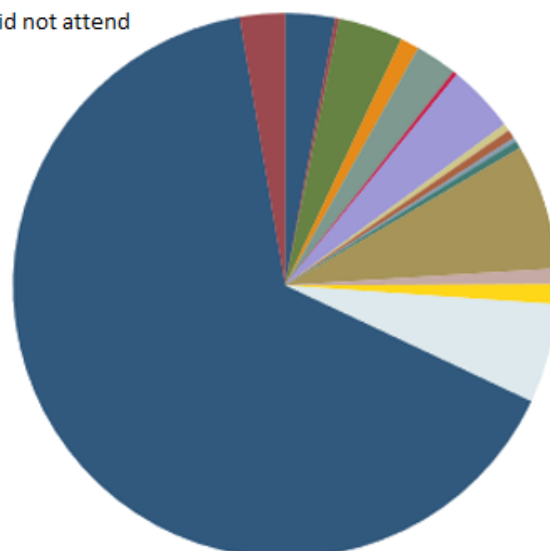
Ethnicity	Number in each group	Number attended	Number did not attend	Percent attended (of group)
Missing	338272	60952	277320	18.02
Asian – Other	21382	16118	5264	75.38
Asian – Bangladeshi	1900	1355	545	71.32
Asian - Indian	26668	20751	5917	77.77
Asian – Pakistani	8780	6088	2692	69.34
Black – African	18851	13716	5135	72.76
Black – Other	1803	1355	448	75.15
Black – Caribbean	28829	22550	6279	78.22

Ethnicity	Number in each group	Number attended	Number did not attend	Percent attended (of group)
Mixed - Other	3122	2353	769	75.37
Mixed – White and Asian	3644	2771	873	76.04
Mixed – White and Black African	1838	1334	504	72.58
Mixed – White and Black Caribbean	3104	2403	701	77.42
Not stated	52928	39052	13876	73.78
Other – Other	6675	5050	1625	75.66
Other – Chinese	8202	6482	1720	79.03
White - Other	42132	31548	10584	74.88
White – British	427186	350243	76943	81.99
White - Irish	18612	14596	4016	78.42

Attended



Did not attend



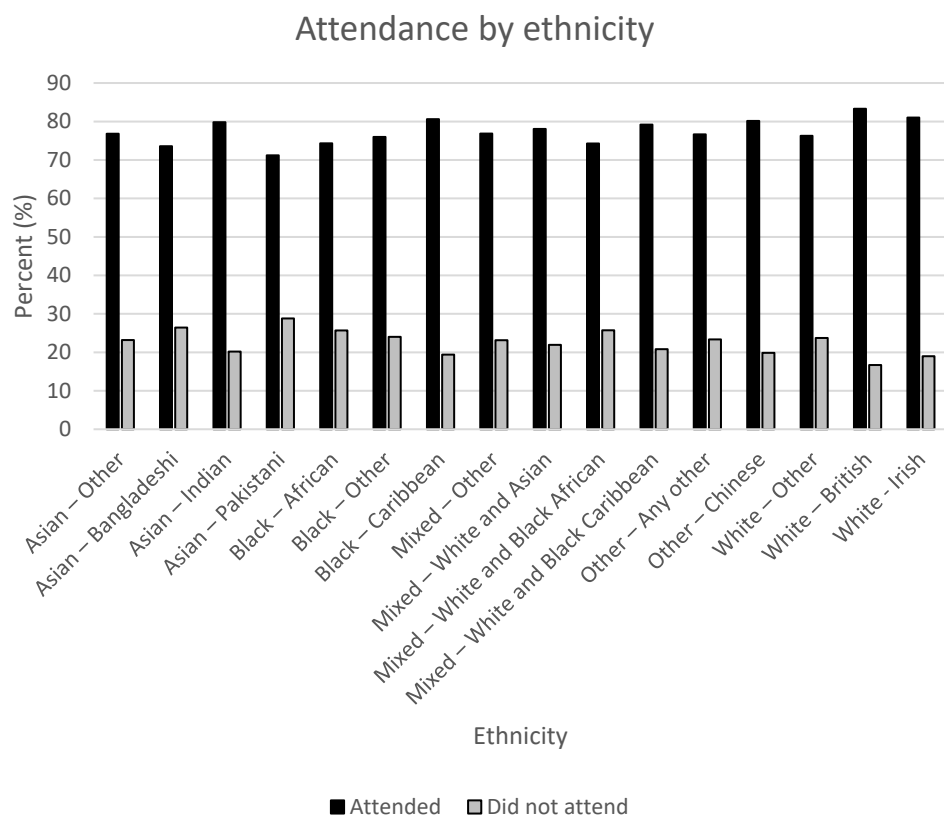


Figure 103. Number of episodes attended by ethnicity group.

8.3.5.5 Special appointment

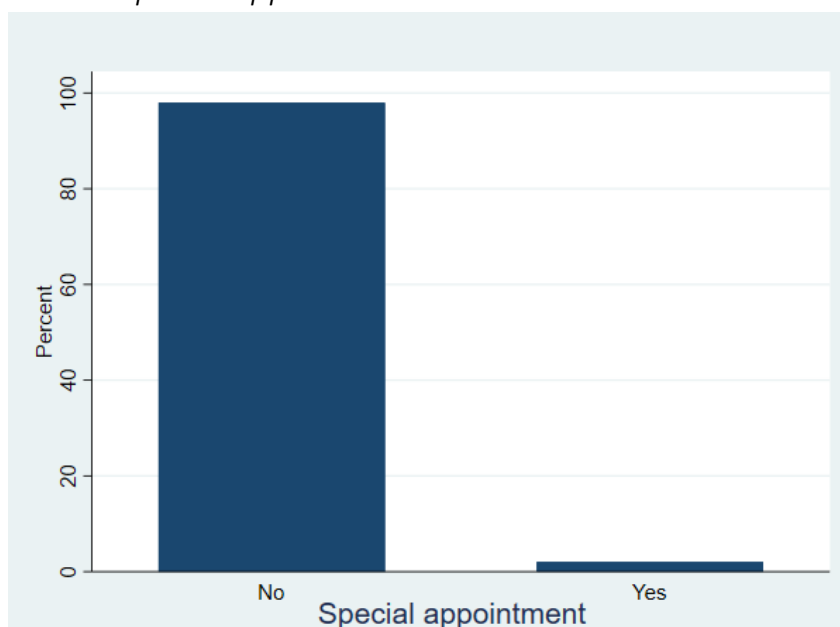


Figure 104. Percentages of women requiring special appointments for BCS

Reason for requiring special appointment	Number	Number attended	Number did not attend	Percent attended (per group)
Agoraphobia	2	0	2	0
Breast Implants	1264	848	416	67.09
Learning difficulties, other	1	1	0	100.00
Learning difficulties, wheelchair user	1	0	1	0
Learning difficulties	1373	760	613	55.35
Other, physical restriction	8	4	4	50.00
Other, registered disabled	3	3	0	100.00
Other, wheelchair user	4	4	0	100.00
Other	2034	1056	978	51.92
Physical restriction, wheelchair user	27	19	8	70.37
Physical restriction	976	692	284	70.90
Registered disabled	300	189	111	63.00
Social reasons	30	8	22	26.60
Wheelchair user	1642	1022	620	62.24
N/A	1006263	594111	412152	59.04

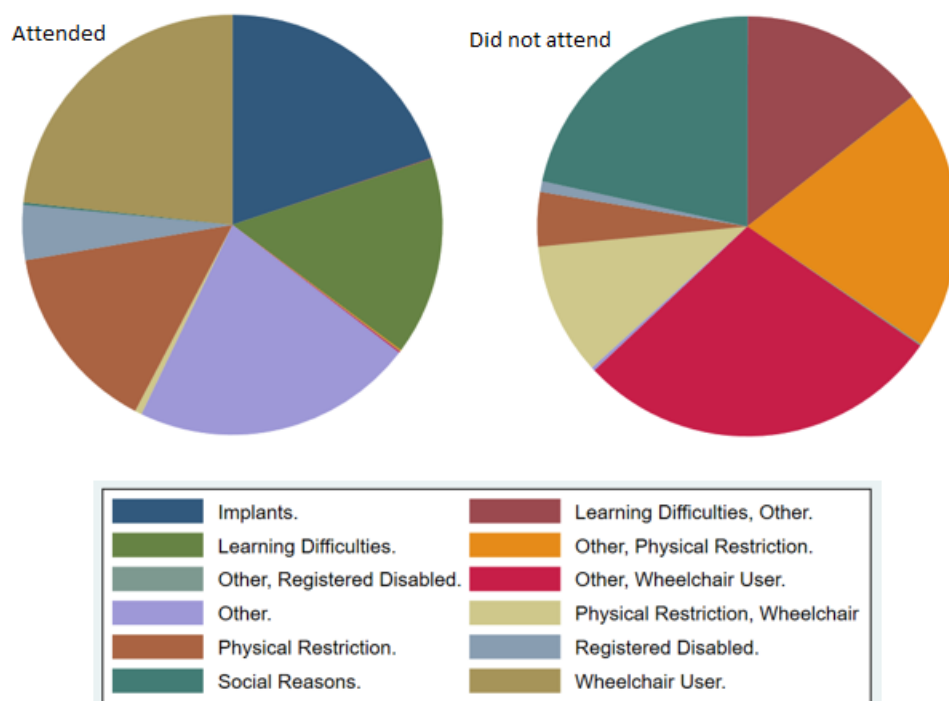


Figure 105. Reasons for special appointment required over attendance

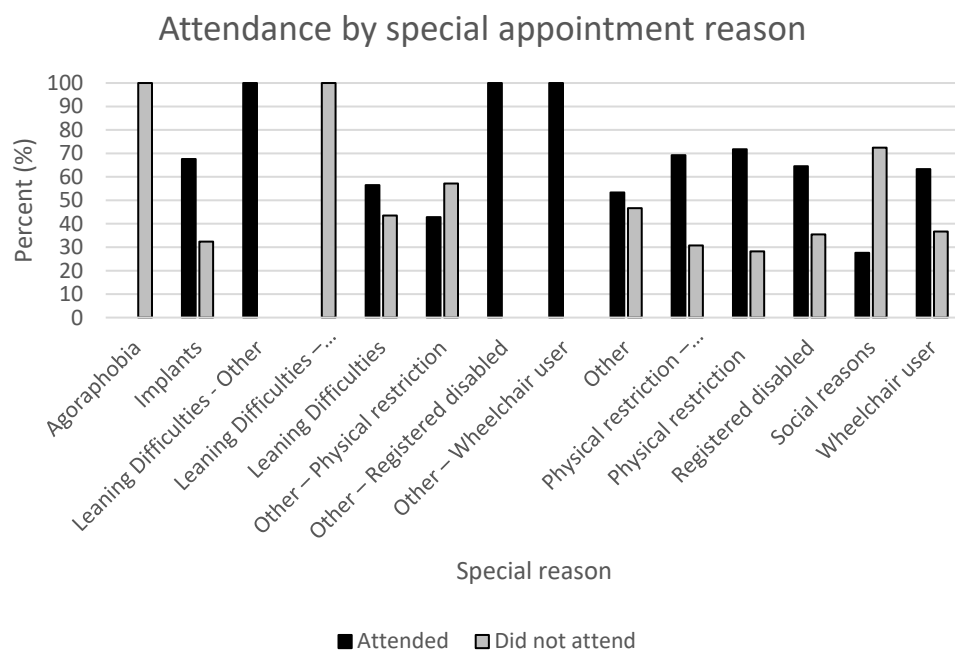


Figure 106. Number of episodes attended by special appointment reason group.

8.2.3.6 Attendance by time (year)

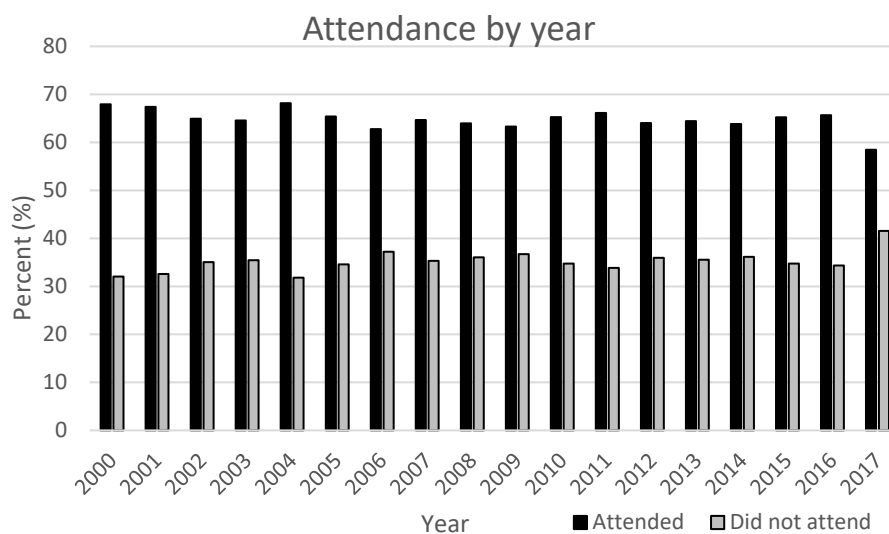


Figure 107. Number of episodes attended by year.

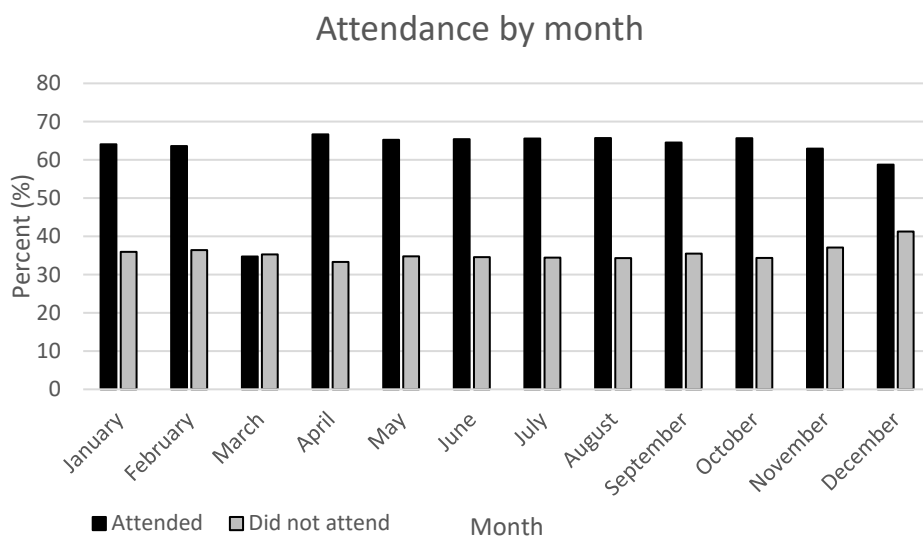


Figure 108. Number of episodes attended by month.

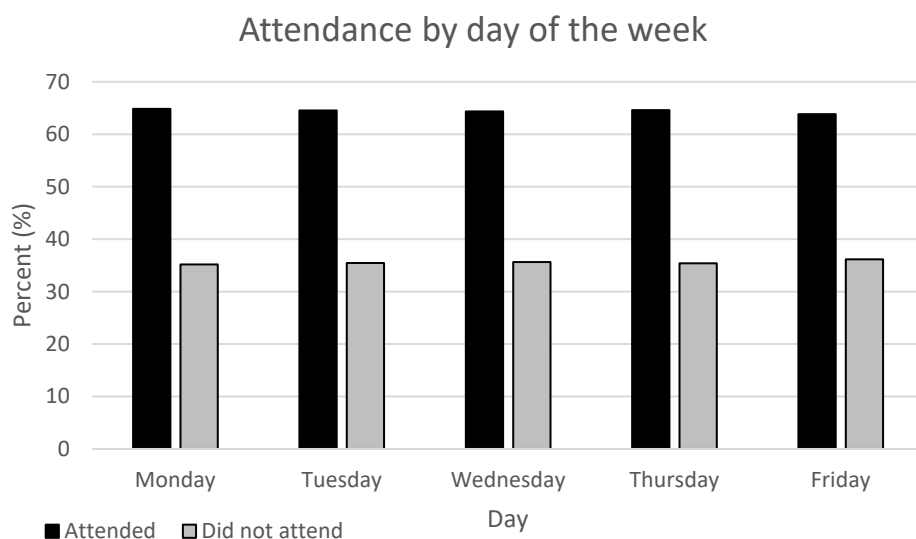


Figure 109. Number of episodes attended by day of the week. Weekend data was removed as it was erroneous data.

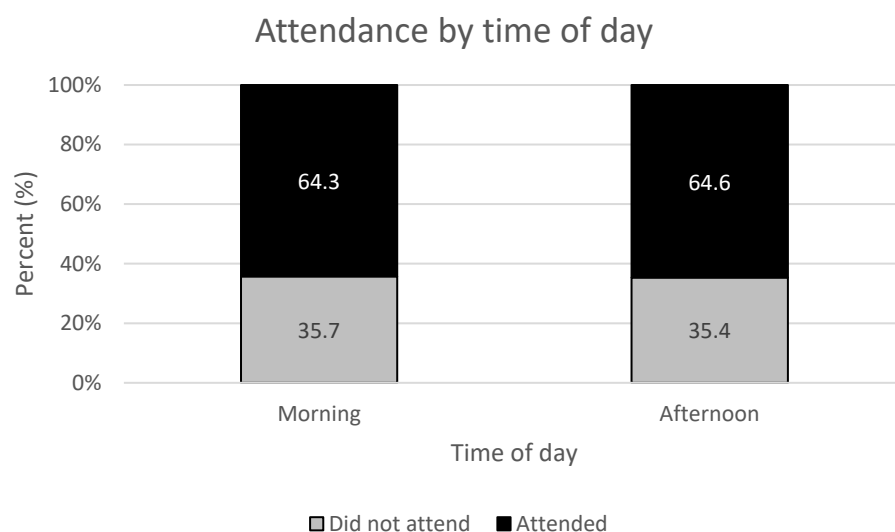


Figure 110. Number of episodes attended by time of day categorise into morning or afternoon.

8.3.6 Assumption testing

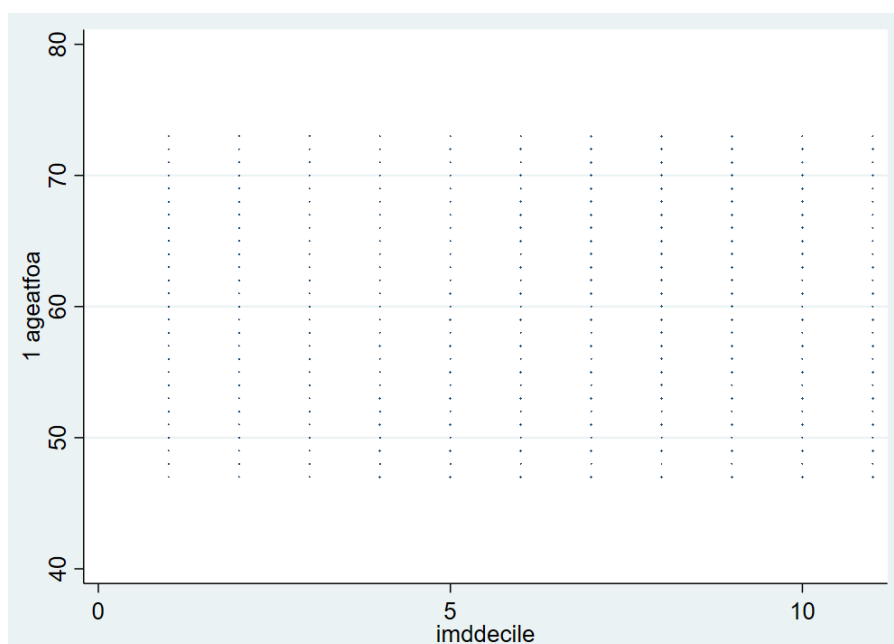


Figure 111. Scatterplot to show association between age at first offered appointment and IMD decile where a value of 1=most deprived and 10= least deprived, 11=N/A or missing.

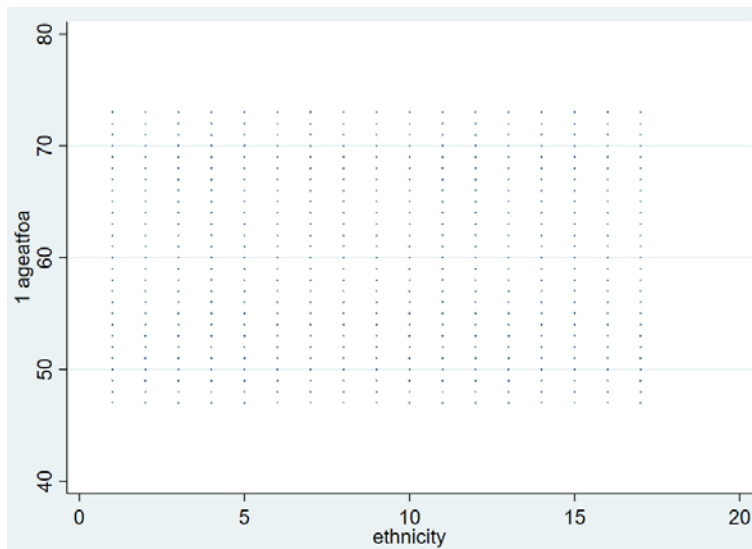


Figure 112. Scatterplot to show association between age at first offered appointment and ethnicity. Ethnicity is defined as 1=asian or asian British – other; 2=asian or asian British – Bangladeshi; 3=asian or asian British – Indian; 4=asian or asian British – Pakistani; 5=black or black British – African; 6=black or black British – other; 7=black or black British – Caribbean; 8=mixed – other; 9=mixed – white and asian; 10=mixed – white and black African; 11=mixed – white and black Caribbean; 12=not stated; 13=other ethnic groups – other; 14=other ethnic groups – Chinese; 15=white – other; 16=white – British.

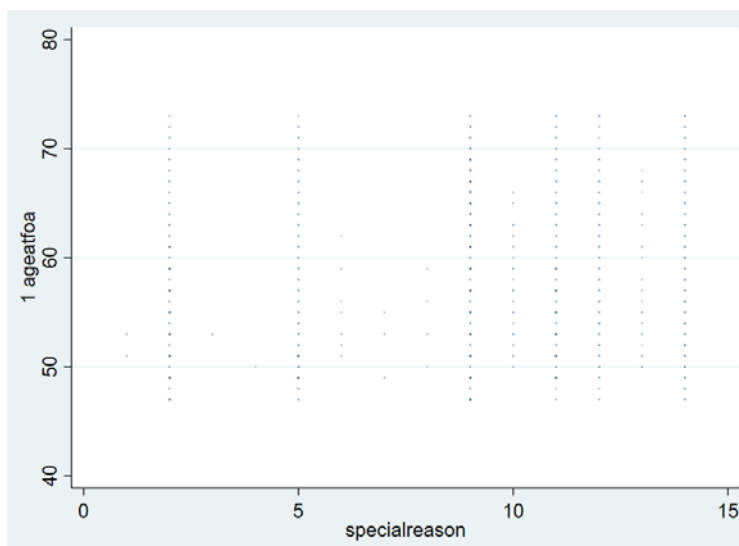


Figure 113. Scatterplot between age at first offered appointment and reason needed for special appointment. Reasons are as follows: 1=agoraphobia; 2=implants; 3=learning difficulty, other; 4=learning difficulty, wheelchair user; 5=learning difficulty; 6=other, physical restriction; 7=other, registered disabled; 8=other, wheelchair user; 9=other; 10=physical restriction, wheelchair user; 11=physical restriction; 12=registered disabled; 13=social reasons; 14=wheelchair user.

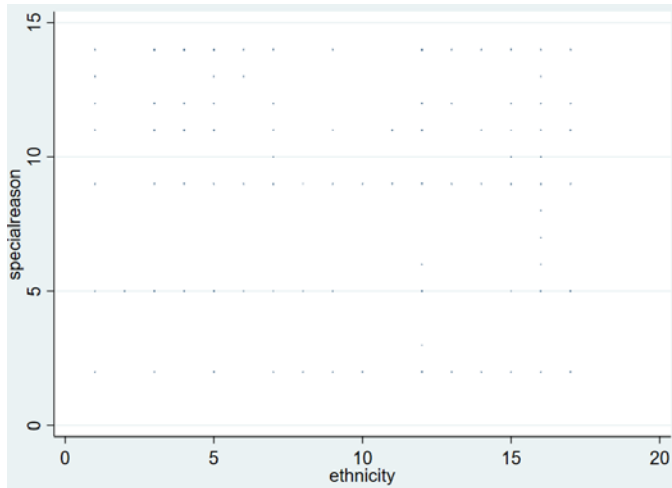


Figure 114. Scatterplot to show association between ethnicity and reason for special appointment. Ethnicity is defined as 1=asian or asian British – other; 2=asian or asian British – Bangladeshi; 3=asian or asian British – Indian; 4=asian or asian British – Pakistani; 5=black or black British – African; 6=black or black British – other; 7=black or black British – Caribbean; 8=mixed – other; 9=mixed – white and asian; 10=mixed – white and black African; 11=mixed – white and black Caribbean; 12=not stated; 13=other ethnic groups – other; 14=other ethnic groups – Chinese; 15=white – other; 16=white – British. Reasons are as follows: 1=agoraphobia; 2=implants; 3=learning difficulty, other; 4=learning difficulty, wheelchair user; 5=learning difficulty; 6=other, physical restriction; 7=other, registered disabled; 8=other, wheelchair user; 9=other; 10=physical restriction, wheelchair user; 11=physical restriction; 12=registered disabled; 13=social reasons; 14=wheelchair user.

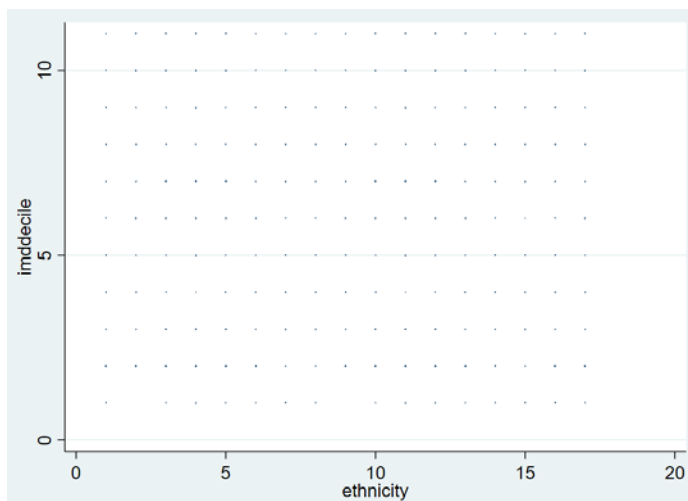


Figure 115. Scatterplot to show association between IMD decile and ethnicity. For IMD, a value of 1=most deprived and 10=least deprived, 11=N/A or missing. Ethnicity is defined as 1=asian or asian British – other; 2=asian or asian British – Bangladeshi; 3=asian or asian British – Indian; 4=asian or asian British – Pakistani; 5=black or black British – African; 6=black or black British – other; 7=black or black British – Caribbean; 8=mixed – other; 9=mixed – white and asian; 10=mixed – white and black African; 11=mixed – white and black Caribbean; 12=not stated; 13=other ethnic groups – other; 14=other ethnic groups – Chinese; 15=white – other; 16=white – British.

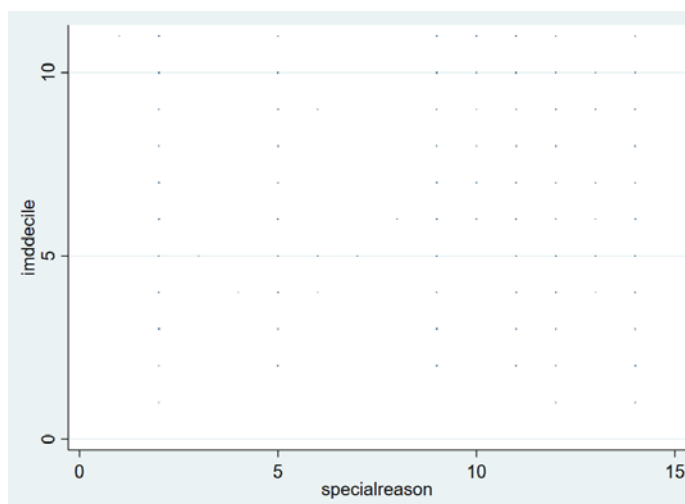


Figure 116. Scatterplot to show association between IMD decile and reason for special appointment. For IMD, a value of 1=most deprived and 10= least deprived, 11=N/A or missing. Reasons are as follows: 1=agoraphobia; 2=implants; 3=learning difficulty, other; 4=learning difficulty, wheelchair user; 5=learning difficulty; 6=other, physical restriction; 7=other, registered disabled; 8=other, wheelchair user; 9=other; 10=physical restriction, wheelchair user; 11=physical restriction; 12=registered disabled; 13=social reasons; 14=wheelchair user.

Predicting ethnicity missingness

```
. logistic ethnicitymissingtest agecategorical i1.specialappt i.imdnew
```

Logistic regression	Number of obs	=	913,905
	LR chi2(11)	=	7721.96
	Prob > chi2	=	0.0000
Log likelihood = -582053.04	Pseudo R2	=	0.0066

ethnicitymissingtest	Odds Ratio	Std. Err.	z	P> z	[95% Conf. Interval]	
agecategorical	.8870902	.0032853	-32.35	0.000	.8806744	.8935527
1.specialappt	.6854277	.0105911	-24.44	0.000	.6649807	.7065035
imdnew						
2	.9548155	.0237271	-1.86	0.063	.9094255	1.002471
3	.9122855	.0224394	-3.73	0.000	.8693484	.9573434
4	.8676398	.0210475	-5.85	0.000	.8273527	.9098885
5	.7608803	.0186554	-11.15	0.000	.725181	.798337
6	.6973232	.0168942	-14.88	0.000	.6649851	.731234
7	.6694062	.016293	-16.49	0.000	.6382223	.7021137
8	.6522086	.0157584	-17.69	0.000	.6220426	.6838374
9	.6014426	.0144031	-21.23	0.000	.5738653	.630345
10	.5611618	.0136374	-23.77	0.000	.5350595	.5885375
_cons	1.403199	.0408303	11.64	0.000	1.325412	1.485551

Note: _cons estimates baseline odds.

Figure 117. Predicting ethnicity missingness. These three were significantly associated with missing ethnicity data.

As age increased, the odds of ethnicity data being missing decreased by 11% compared with younger women, OR 0.89 (0.88, 0.89), $p < 0.001$. If a woman required a special appointment (for example due to disability or having breast implants) the odds of ethnicity data being

missing decreased by 31%, OR 0.69 (0.66, 0.71), $p < 0.001$. The odds of having missing ethnicity data were 46% lower in women with low SES (IMD=1) compared with women of high SES (IMD=10), OR 0.56 (0.54, 0.59), $p < 0.0001$.

Predicting IMD missingness

```
. logistic imdmissingness agecategorical ib16.ethnicity2
note: 2.ethnicity2 != 0 predicts failure perfectly
      2.ethnicity2 dropped and 1823 obs not used
```

```
note: 9.ethnicity2 != 0 predicts failure perfectly
      9.ethnicity2 dropped and 3497 obs not used
```

```
Logistic regression      Number of obs      =      598,228
                        LR chi2(14)           =       63.34
                        Prob > chi2            =       0.0000
Log likelihood = -3826.7477      Pseudo R2          =       0.0082
```

imdmissingness	Odds Ratio	Std. Err.	z	P> z	[95% Conf. Interval]	
agecategorical	.7444984	.0595437	-3.69	0.000	.636482	.8708462
ethnicity2						
Asian or Asian British - Any other Asian background	.9627041	.2466436	-0.15	0.882	.5826612	1.590631
Asian or Asian British - Bangladeshi	1 (empty)					
Asian or Asian British - Indian	.1970364	.0991278	-3.23	0.001	.0735042	.5281784
Asian or Asian British - Pakistani	1.3517	.4569826	0.89	0.373	.6967969	2.622132
Black or Black British - African	1.297425	.3064973	1.10	0.270	.8165799	2.061418
Black or Black British - Any other Black background	2.781683	1.401521	2.03	0.042	1.036189	7.467518
Black or Black British - Caribbean	1.140452	.2368001	0.63	0.527	.7591648	1.713239
Mixed - Any other Mixed background	2.065201	.9314926	1.61	0.108	.8531683	4.99908
Mixed - White and Asian	1 (empty)					
Mixed - White and Black African	2.11187	1.226038	1.29	0.198	.6768704	6.589144
Mixed - White and Black Caribbean	4.605568	1.41462	4.97	0.000	2.522511	8.408787
Other ethnic groups - Any other ethnic group	.7633193	.384147	-0.54	0.592	.2846635	2.046825
Other ethnic groups - Chinese	.7806378	.3519099	-0.55	0.583	.3226485	1.888728
White - Any other White background	1.048606	.1890678	0.26	0.792	.7364403	1.493095
White - Irish	.5833995	.2088499	-1.51	0.132	.289232	1.176754
_cons	.0015763	.000303	-33.57	0.000	.0010814	.0022975

Note: _cons estimates baseline odds.

Figure 118. Predicting IMD missingness. These variables were significantly associated with missing IMD data

As age group increased the likelihood of SES data being missing decreased by 26%, OR 0.74 (0.64, 0.87), $p < 0.001$. Compared with White women the odds of Indian women having missing SES data were 80% lower, OR 0.20 (0.07, 0.53), the odds of Black women having missing data were 278% higher, OR 2.78 (1.04, 7.47), and Mixed ethnicity women were 461% more likely to have missing data when compared with White women, OR 4.61 (2.52, 8.41) all $p < 0.001$. Women requiring a special appointment were not significantly more likely to have SES data than those not requiring a special appointment.

8.3.7 Multilevel modelling

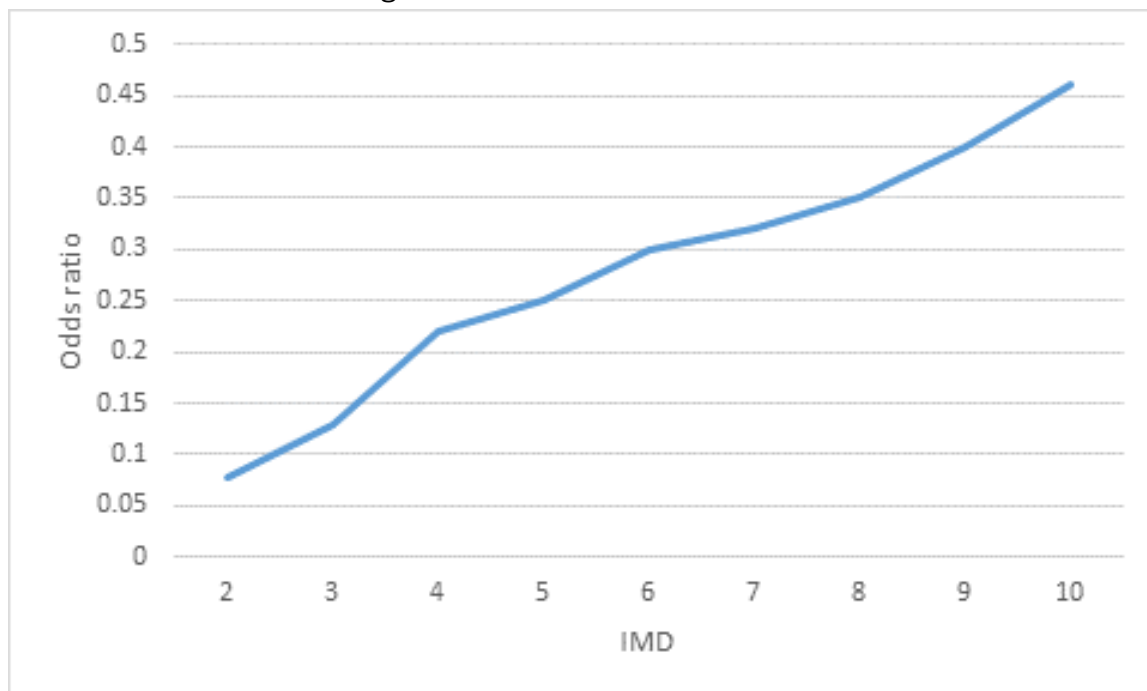


Figure 119. Odd ratios of socioeconomic status is shown to be a linear effect. However, the odds ratios in table format do not appear as linear and consequently SES was kept in the model as a categorical variable. This is most appropriate as IMD does not linearly increase or decrease in deprivation anyway.

Log likelihood = -274537.31		Wald chi2(21)	=	3561.46		
		Prob > chi2	=	0.0000		
attendedonce		Odds Ratio	Std. Err.	z	P> z	[95% Conf. Interval]
agecategorical						
2		.7715657	.0195659	-10.23	0.000	.7341546 .8108832
3		.8211534	.0220219	-7.35	0.000	.7791059 .8654701
4		.6013309	.0215873	-14.17	0.000	.5604748 .6451653
1.specialappt		1.9972	.076273	18.11	0.000	1.853165 2.152429
preveprecall		1.225622	.011843	21.05	0.000	1.202629 1.249055
imdnew		1.043984	.0022951	19.58	0.000	1.039496 1.048492
ethnicity2						
Asian or Asian British - Any other Asian background		.623197	.0172453	-17.09	0.000	.5902971 .6579305
Asian or Asian British - Bangladeshi		.5266318	.0478038	-7.06	0.000	.4407996 .6291773
Asian or Asian British - Indian		.7723076	.0200744	-9.94	0.000	.7339478 .8126722
Asian or Asian British - Pakistani		.4487636	.0184666	-19.47	0.000	.4139909 .486457
Black or Black British - African		.5732276	.0164937	-19.34	0.000	.5417953 .6064836
Black or Black British - Any other Black background		.6512181	.057909	-4.82	0.000	.5470589 .7752091
Black or Black British - Caribbean		.8850929	.0223264	-4.84	0.000	.8423981 .9299517
Mixed - Any other Mixed background		.641232	.0448874	-6.35	0.000	.5590229 .7355307
Mixed - White and Asian		.67977	.0452427	-5.80	0.000	.596636 .7744877
Mixed - White and Black African		.5595343	.0500561	-6.49	0.000	.4695459 .666769
Mixed - White and Black Caribbean		.7991236	.0573259	-3.13	0.002	.6943081 .9197625
Other ethnic groups - Any other ethnic group		.614231	.0294685	-10.16	0.000	.5591062 .6747907
Other ethnic groups - Chinese		.7571404	.0341177	-6.17	0.000	.6931389 .8270516
White - Any other White background		.5730598	.0113462	-28.12	0.000	.5512477 .595735
White - Irish		.8363499	.0262462	-5.69	0.000	.7864583 .8894066
_cons		3.742457	.1796231	27.50	0.000	3.406454 4.111602
nhscopytic						
var(_cons)		1.693417	.0187804			1.657005 1.730629

Note: Estimates are transformed only in the first equation.

Note: _cons estimates baseline odds (conditional on zero random effects).

LR test vs. logistic model: $\chi^2(01) = 28782.26$ Prob >= $\chi^2(01) = 0.0000$

Figure 120. Sensitivity analysis using IMD as a continuous variable.

Using specialreason rather than specialappt gave all non-significant results whereas specialappt on its own was significant.

8.3.7.1 Associations of attendance at any episode

Table 40. Summary of multilevel model output

```
. tabulate agecategorical ethnicity2, rowsort
```

agecategor icallabel	ethnicity2															Total	
	Asian or	Asian or	Asian or	Asian or	Black or	Black or	Black or	Mixed - A	Mixed - W	Mixed - W	Mixed - W	Other eth	Other eth	White - A	White - B	White - I	
2	12,690	1,059	14,909	4,930	11,391	1,183	16,639	1,847	2,014	1,103	1,809	4,094	4,857	23,799	234,991	9,857	346,358
3	7,052	675	9,611	3,096	5,796	446	9,552	1,021	1,275	560	1,015	2,077	2,745	14,852	161,627	7,918	229,318
1	809	66	847	285	873	119	1,047	132	159	83	136	275	332	1,697	12,817	416	20,086
4	372	38	589	200	330	26	677	53	87	39	74	112	140	894	10,336	596	14,563
Total	20,923	1,838	25,956	8,511	18,390	1,767	27,915	3,053	3,535	1,785	3,027	6,558	8,074	41,235	419,771	17,987	610,325

Figure 121. Cross tabulation of age and ethnicity groups.

Final model for research question one: **melogit attendedonce i.agecategorical i1.specialappt preveprecall i.imdnew ib5.ethnicitygroup || nhscryptic: , or**

Log likelihood = -275073.36 Wald chi2(18) = 2485.34
 Prob > chi2 = 0.0000

attendedonce	Odds Ratio	Std. Err.	z	P> z	[95% Conf. Interval]	
agecategorical						
2	.7769582	.0197181	-9.94	0.000	.7392569	.8165823
3	.8270374	.0222003	-7.07	0.000	.7846504	.8717142
4	.6063309	.0217841	-13.93	0.000	.5651035	.6505661
1.specialappt	1.975883	.0758328	17.74	0.000	1.832706	2.130246
preveprecall	1.217715	.0117672	20.38	0.000	1.194868	1.240998
imdnew						
2	1.099848	.0685001	1.53	0.126	.973461	1.242644
3	1.158607	.0714276	2.39	0.017	1.026738	1.307411
4	1.286774	.07829	4.14	0.000	1.142125	1.449744
5	1.318781	.0808925	4.51	0.000	1.169394	1.487251
6	1.386289	.0841061	5.38	0.000	1.230867	1.561335
7	1.40471	.0855955	5.58	0.000	1.246577	1.582903
8	1.457531	.0882736	6.22	0.000	1.294392	1.641231
9	1.553366	.0933289	7.33	0.000	1.380805	1.747493
10	1.636302	.0995216	8.10	0.000	1.452421	1.843463
ethnicitygroup						
Asian	.6855336	.0121288	-21.34	0.000	.6621691	.7097225
Black	.7847122	.0152685	-12.46	0.000	.75535	.8152158
Mixed	.7214241	.02679	-8.79	0.000	.6707819	.7758896
Other	.7312178	.024313	-9.41	0.000	.6850846	.7804575
_cons	3.38818	.2511714	16.46	0.000	2.929985	3.918027
nhscryptic						
var(_cons)	1.72581	.019038			1.688897	1.76353

Note: Estimates are transformed only in the first equation.

Note: _cons estimates baseline odds (conditional on zero random effects).

LR test vs. logistic model: $\chi^2(01) = 29490.15$ Prob >= $\chi^2 = 0.0000$

Figure 122. Output of the first model

8.3.7.2 Associations of attendance at first episode

```
. tab2 attendedonce year, chi2 column lrchi2 rowsort
```

-> tabulation of attendedonce by year

Key
frequency
column percentage

attendedonce	year																Total
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
Attended once per epi	23,555 67.94	27,343 67.40	26,949 64.94	24,518 64.56	29,453 68.17	26,884 65.40	33,552 62.82	36,257 64.67	31,031 63.95	32,197 63.29	35,527 65.25	35,214 66.14	31,848 64.03	31,496 64.43	44,981 63.86	36,325 65.22	596,776 64.44
No attendance in any	11,113 32.06	13,223 32.60	14,547 35.06	13,461 35.44	13,752 31.83	14,225 34.60	19,857 37.18	19,804 35.33	17,495 36.05	18,672 36.71	18,923 34.75	18,031 33.86	17,889 35.97	17,388 35.57	25,455 36.14	19,374 34.78	329,281 35.56
Total	34,668 100.00	40,566 100.00	41,496 100.00	37,979 100.00	43,205 100.00	41,109 100.00	53,409 100.00	56,061 100.00	48,526 100.00	50,869 100.00	54,450 100.00	53,245 100.00	49,737 100.00	48,884 100.00	70,436 100.00	55,699 100.00	926,057 100.00

attendedonce	year			Total
	2016	2017	2018	
Attended once per epi	42,687 65.72	46,959 58.62	0 0.00	596,776 64.44
No attendance in any	22,262 34.28	33,143 41.38	667 100.00	329,281 35.56
Total	64,949 100.00	80,102 100.00	667 100.00	926,057 100.00

Pearson chi2(18) = 3.3e+03 Pr = 0.000
likelihood-ratio chi2(18) = 3.4e+03 Pr = 0.000

Figure 123. Cross tabulation of year and attendance at the first appointment within an episode

```
. tab2 attendedonce dow, chi2 column lrchi2 rowsort
```

-> tabulation of attendedonce by dow

Key
frequency
column percentage

attendedonce	dow							Total
	0	1	2	3	4	5	6	
Attended once per epi	676 52.36	95,933 64.83	126,424 64.55	133,750 64.35	140,141 64.61	93,799 63.84	6,053 65.65	596,776 64.44
No attendance in any	615 47.64	52,046 35.17	69,445 35.45	74,107 35.65	76,776 35.39	53,125 36.16	3,167 34.35	329,281 35.56
Total	1,291 100.00	147,979 100.00	195,869 100.00	207,857 100.00	216,917 100.00	146,924 100.00	9,220 100.00	926,057 100.00

Pearson chi2(6) = 125.1115 Pr = 0.000
likelihood-ratio chi2(6) = 121.9713 Pr = 0.000

Figure 124. Cross tabulation of day of the week and attendance at the first appointment within an episode

Log likelihood = -48083.262		Wald chi2(20) = 1257.29		Prob > chi2 = 0.0000	
attendedonce	Odds Ratio	Std. Err.	z	P> z	[95% Conf. Interval]
ageatfoal					
48	.6416728	.1075838	-2.65	0.008	.4619553 .8913071
49	.1517022	.0201086	-14.23	0.000	.1169936 .1967077
50	.155042	.0203729	-14.19	0.000	.1198394 .2005854
51	.1688491	.022181	-13.54	0.000	.1305208 .2184326
52	.1387873	.0182468	-15.02	0.000	.1072605 .1795806
53	.0756651	.0100595	-19.42	0.000	.0583083 .0981887
2.specialappt	.514425	.0357601	-9.56	0.000	.4489014 .5895127
ethnicitygroup					
Asian	.7432585	.0228715	-9.64	0.000	.6997563 .7894652
Black	.8462925	.0281186	-5.02	0.000	.7929372 .9032381
Mixed	.8238994	.0519732	-3.07	0.002	.7280794 .9323299
Other	.7892294	.0442813	-4.22	0.000	.7070414 .8809709
imddecile					
IMD2	1.222761	.1365965	1.80	0.072	.9823188 1.522056
IMD3	1.189889	.1316218	1.57	0.116	.957964 1.477964
IMD4	1.247464	.1362101	2.03	0.043	1.00713 1.545149
IMD5	1.213156	.1336461	1.75	0.079	.9775634 1.505527
IMD6	1.270955	.138549	2.20	0.028	1.026453 1.573697
IMD7	1.351776	.1482055	2.75	0.006	1.090388 1.675824
IMD8	1.302241	.1418046	2.43	0.015	1.051966 1.61206
IMD9	1.344775	.1452608	2.74	0.006	1.088188 1.661863
IMD10	1.421808	.1555895	3.22	0.001	1.147344 1.76193
_cons	37.96633	6.442222	21.43	0.000	27.22479 52.94593
nhscryptic					
var(_cons)	1.053319	.0744826			.9170001 1.209902

Note: Estimates are transformed only in the first equation.

Note: _cons estimates baseline odds (conditional on zero random effects).

LR test vs. logistic model: chibar2(01) = 376.65 Prob >= chibar2 = 0.0000

Figure 125. Output of model for the second model

8.3.7.3 Have influences of attendance changed over time?

Attended first episode

Melogit attendedonce c.year || nhscryptic: , or

```
Mixed-effects logistic regression      Number of obs      =    926,057
Group variable:      nhscryptic        Number of groups    =    304,616

Obs per group:
      min =          1
      avg =         3.0
      max =         11

Integration method: mvaghermite        Integration pts.    =          7

Log likelihood = -506388.01              Wald chi2(1)        =    1223.54
                                          Prob > chi2          =     0.0000
```

attendedonce	Odds Ratio	Std. Err.	z	P> z	[95% Conf. Interval]	
year	.9750477	.0007044	-34.98	0.000	.9736681	.9764292
_cons	2.96e+22	4.30e+22	35.63	0.000	1.72e+21	5.09e+23
nhscryptic var(_cons)	6.989005	.0515802			6.888637	7.090835

Note: Estimates are transformed only in the first equation.

Note: _cons estimates baseline odds (conditional on zero random effects).

LR test vs. logistic model: $\chi^2(01) = 1.9e+05$ Prob >= $\chi^2 = 0.0000$

Figure 126. Year is a significant predictor of attendance

8.4 Questionnaire Study

This questionnaire has been based on the IBIS risk prediction model. A screenshot of the user interface is provided below.

Figure 127. Screenshot of IBIS risk predictor model

8.4.1 Participant information sheet



PARTICIPANT

INFORMATION LEAFLET

Study Title: A questionnaire development study to investigate predictors of uptake of mammography

Investigator(s): Rebecca Crosby (Researcher), Dr Chris Stinton (Supervisor), Mr D Gallacher & Professor Aileen Clarke (Supervisor)

Introduction

We would really value your help in developing this questionnaire. We believe the information we will gather as a result of using this questionnaire in practice in the future will enable us to improve the understanding of uptake and participation at breast screening, benefitting potentially millions of women in the UK. Before you decide whether to take part, you need to understand why the study is being done and what it may involve for you. Please take the

time to read the following information carefully. Feel free to talk to others about the study if you wish to discuss any concerns you may have.

Part 1 below tells you more about me, the purpose of the study and what will happen to you if you take part. Part 2 gives you more detailed information about the official conduct of the study.

Please feel free to ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

PART 1

Who is organising the study?

My name is Rebecca Crosby. I am a third year PhD student at the University of Warwick. My research is investigating factors that may be influencing participation in the breast screening programme. My work is funded by a studentship from the NIHR CLAHRC West Midlands initiative. This study will contribute to my doctoral qualification in health sciences from Warwick Medical School which I aim to finish in September 2018.

What is the study about?

I am developing a questionnaire for future use.

The questionnaire will ask about some of your personal characteristics and some background information about your medical history. The questionnaire will also ask about your attitude about breast screening and behaviour, such as whether you have been screened before. These questions are asked to assess different factors that may influence participation at breast screening. These questions may seem very detailed and you may be wondering why we need so much information about your family medical background. The reason is that one of our ideas is that a woman's decision to participate in breast screening may be affected by her own perceived risk of breast cancer. Anecdotally, we know that some women may feel that their own risk of breast cancer may be affected by factors such as bodyweight, age of first period, time spent breastfeeding and having female family members who have had had cancer etc. Ultimately, we hope information gathered by this questionnaire will identify what factors are influencing or deterring women to attend mammography. Currently, there is very contradictory evidence which suggests that women who perceive their own risk as higher, may be either less likely or more likely to attend screening. With better evidence of how women's own perceived risk affects their decision to participate in screening, we hope to be able to target and communicate to women more effectively in the UK breast screening programme.

The questionnaire is still being developed and we need to know women's thoughts on it before sending it out as a larger research project. This is where we have asked you for your help.

What will happen to the results of the study?

Developing this questionnaire is a very important part of my research design as it will improve the quality of the final questionnaire used in any future research which rolls-out the questionnaire to thousands of women in order to assess factors influencing uptake of breast screening.

It is vital for us to accurately establish the factors that may influence participation in breast screening. We aim to use this information to help reshape the breast screening programme, which may result in a better, more personalised approach to targeting and inviting women to breast screening. We hope that this will lead to a reduction health inequalities amongst underprivileged women

We will present the research findings at relevant conferences and breast screening meetings at hospitals responsible for BCS services. Results will be published in appropriate academic journals in a timely manner. Any discussion about the development will not include who participated in the development process so your participation will be kept confidential.

If you desire, as part of the development team, you will be sent a copy of the results and outcomes of both the development and the final questionnaire at the end of the relevant study phase.

Why should I take part?

It is entirely up to you to decide but we would really value your input and contribution into the development of this questionnaire in such an important area of women's health. With your help, we can make sure the final questionnaire used with potentially thousands of women is as good as it possibly can be, giving us the best quality evidence for future research and practice.

What will happen to me if I take part?

We will describe the process and go through this information sheet, which we will give you to keep. If you choose to participate, we will ask you to sign a consent form to confirm that you have agreed to take part. You will be free to withdraw at any time, without giving a reason and this will not affect you or your circumstances in any way.

I will give you a copy of the questionnaire for you to complete. However, rather than completing this on your own I will ask you to complete something called a 'cognitive interview'. This is simply you answering the questionnaire whilst thinking aloud and explaining to me what each question means to you as you read it. I will also ask you to explain your thinking about why you are choosing each answer. There are no right or wrong answers at this stage and all the information is useful. This should take no longer than 30 minutes.

At the end of the questionnaire I will ask you one more question 'is there anything else you would like to add about the questionnaire'. This is an opportunity for you to give me any more information that might be useful or to point out something I have missed from the questionnaire.

We anticipate the whole process (reading the participant information sheet, consenting and conducting the cognitive interview) will take approximately one hour of your time.

What are the possible disadvantages of taking part in this study?

Helping with the development of this questionnaire may be uncomfortable for you if you have had any negative experiences with the breast health of yourself or someone close to you or you may have had a negative breast screening experience in the past. There is no obligation for you to complete this questionnaire and you may stop at any time without any issues.

If I witness you becoming distressed at any time I will stop the interview and give you information about where you can access help or information about something that is troubling you.

This will not impact your medical healthcare and you will be invited to any breast screening process as normal.

What are the possible benefits of taking part in this study?

We are asking you to participate in research that will hopefully be used to improve the breast screening programme in the future. You are helping to improve my research to ensure the questionnaire is useful and gives the best quality information. This may benefit thousands of women involved in the breast screening programme in the future. If you want, you will be provided the results of the study to keep up to date with what is happening.

Expenses and payments

Unfortunately we are not able to fund any expenses or payments for the completion of this cognitive interview. Instead, the cognitive interview will be conducted at a time and place convenient for yourself.

This concludes Part 1.

If the information in Part 1 has interested you and you are considering participation, please read the additional information in Part 2 before making any decision.

PART 2

What will happen if I change my mind later about being part of the study?

Your participation in this study is entirely voluntary. Any decision you make either now or at any point in the future to not participate will not affect you in any way. If you decide to take part in the study, we will ask you to sign a consent form, which states that you have given your consent to participate.

If you agree to participate, you have the right to withdraw from the study at any time and decline any further contact by study staff without affecting you in any way.

Your medical care and invitation to future breast screening appointments will not be affected as your involvement in this research is completely confidential. The care you are entitled to will not change as a result of participation or non-participation in this research.

What if there is a problem?

This study is covered by the University of Warwick's insurance and indemnity cover. If you have an issue, please contact the Chief Investigator of the study:

Aileen Clarke,
Warwick Medical School,
University of Warwick,
Coventry,
CV4 7AJ

Email: Aileen.Clarke@warwick.ac.uk

Telephone: 02476 150189

Who should I contact if I wish to make a complaint?

Any complaint about the way you have been dealt with during the study or any possible harm you might have suffered will be fully investigated and addressed. Please address your complaint to the person below, who is a senior University of Warwick official entirely independent of this study:

Head of Research Governance

Research & Impact Services
University House
University of Warwick
Coventry
CV4 8UW
Tel: 024 76 522746
Email: researchgovernance@warwick.ac.uk

Will my taking part be kept confidential?

Yes. We will follow strict ethical and legal practice and all information about you will be handled in confidence. Data and the informed consent forms will be stored as password protected files on encrypted computers for ten years as per University of Warwick guidelines. Paper formats of

returned questionnaires will also be stored for ten years in a locked filing cabinet in a secure office that only the research team has access to as per the University of Warwick guidelines.

All questionnaires and interviews will be completed confidentially.

Who has reviewed the study?

This study has been reviewed and given favourable opinion by the University of Warwick's Biomedical and Scientific Research Ethics Committee (BSREC): REGO-2017-2118. Approval was granted on the 3rd January 2018.

What if I want more information about the study?

If you have any questions about any aspect of the study, or your participation in it, not answered by this participant information leaflet, please contact:

Researcher

Rebecca Crosby
Farmhouse,
Warwick Medical School,
Gibbet Hill Road,
Coventry,
CV4 7AJ

Email: R.Crosby@warwick.ac.uk

Telephone: 02476 574785

Chief Investigator and Academic Supervisor

Aileen Clarke
Warwick Medical School,

University of Warwick,
Coventry,
CV4 7AJ

Email: Aileen.Clarke@warwick.ac.uk

Telephone: 02476 150189

Thank you for taking the time to read this participant information leaflet.

8.4.2 Questionnaire (original)

A. Personal risk of breast cancer

In this section the questions asked are specific to your medical history. Please answer as carefully and accurately as you can so your personal risk of breast cancer can be calculated.

1. How tall are you without shoes? (metric or imperial) _____
2. How much do you weigh unclothed? (metric or imperial) _____
3. Have you given birth? *(please circle)*
 - a. Yes (please continue)
 - b. No (please go to question 6)
4. How old were you at the first birth? _____ (years)
5. How old were you when you started your first period? _____ (years)
6. Are you still having regular periods? *(please circle)*
 - a. Yes (please go to question 14)

- b. No (please continue)
7. Have your periods completely stopped? *(please circle)*
- a. Yes (please continue)
 - b. No (please go to question 14)
8. How old were you when you went through the menopause? _____ (years)
9. Have you ever used hormone replacement therapy (HRT)?
- a. Yes (please continue)
 - b. No (please go to question 14)
10. When did you use HRT? *(please circle)*
- a. 5 or more years ago
 - b. Less than 5 years ago
 - c. Current user
11. How long did you use HRT for in total? _____ years
12. Have you been previously diagnosed with a breast disease? *(please circle)*
- a. Yes (please continue)
 - b. No (please go to question 8)
13. What have you been diagnosed with? *(please tick all that apply)*
- a. Prior biopsy conducted, result unknown ☐
 - b. Hyperplasia (not atypia) ☐
 - c. Atypical hyperplasia ☐
 - d. Lobular carcinoma in situ (LCIS) ☐
 - e. Ovarian cancer ☐
14. Have any relatives been diagnosed with ovarian cancer?
- a. Yes (please continue)
 - b. No (please go to question 16)

15. If you answered yes, please complete the table below identifying which relatives were diagnosed with ovarian cancer and at what age? *(please complete for all relatives that this applies)*

Family Member	Diagnosed with Ovarian cancer? (yes/no)	At what age? (years)
Mother		
Sister(s) (Please use a new line for each sister)		
Paternal Grandmother		
Maternal Grandmother		
Paternal aunt(s) Please use a new line for each aunt		
Maternal aunt(s) Please use a new line for each aunt		
Daughter(s) Please use a new line for each daughter		
For the below relatives please provide detail on your family linkage. For example a cousin could be described as "paternal cousin".		
Half-sister(s) Please use a new line for each half sister		
Affected cousin(s) Please use a new line for each cousin		
Affected niece(s) Please use a new line for each niece		

16. Have any relatives been diagnosed with breast cancer?

- a. Yes (please continue)
- b. No (please go to question 18)

17. If you answered yes, please complete the table below identifying which relatives were diagnosed with breast cancer, at what age and if this cancer was present in both breasts (bilateral)? *(please complete for all relatives that this applies)*

Family Member	Diagnosed with Breast Cancer?	At what age?	Was this bilateral breast cancer?
Mother			
Sister(s) Please use a new line for each sister			
Paternal Grandmother			
Maternal Grandmother			
Paternal aunt(s) Please use a new line for each aunt			
Maternal aunt(s) Please use a new line for each aunt			
Daughter(s) Please use a new line for each daughter			
For the below relatives please provide detail on your family linkage. For example a cousin could be described as "paternal cousin".			
Half sister(s) Please use a new line for each half sister			
Affected cousin(s) Please use a new line for each cousin			
Affected niece(s) Please use a new line for each niece			

18. Have you or anyone in your family been genetically tested for BRCA1 or BRCA2 genes? *(Please circle)*

- a. Yes (please continue)
- b. No (please go to question 20)
- c. Don't know

19. If you know the results, please indicate below.

Family Member	Negative result	BRCA1 positive	BRCA2 positive
Individual (you)			
Father			
Mother			
Sister(s) Please use a new line for each sister			
Daughter(s) Please use a new line for each daughter			
Paternal Grandmother			
Maternal Grandmother			
Paternal aunt			
Maternal aunt			

B. Informed Choice

The questions asked in this section are based on research conducted in Sydney, Australia by Mathieu and colleagues.

Knowledge

This part of the questionnaire is asking about your knowledge about breast screening. You will not be judged by right or wrong answers and your healthcare will not be affected.

1. What is screening used for? *(please circle)*
 - a. To test what is wrong with unhealthy people
 - b. To find illnesses in currently healthy people
 - c. To determine who deserves treatment and who does not
 - d. Don't know

2. What is a screening mammogram? *(please circle)*
 - a. Detects if cancer is present in those who have a lump in their breast
 - b. Checks for signs of breast cancer in healthy women
 - c. Don't know

3. Does every woman with a 'positive' mammogram result have breast cancer? *(please circle)*
- a. Yes
 - b. No
 - c. Don't know
4. What does it mean if a woman receives a 'negative' mammogram result? *(please circle)*
- a. She will not get cancer in the future
 - b. The mammogram did not work
 - c. She does not have cancer that can be detected at the moment
 - d. Don't know
5. Which groups have the highest rates of breast cancer detected? *(please circle)*
- a. Women who attend screening
 - b. Women who do not attend screening
 - c. Don't know
6. Some women are diagnosed with a cancer that never would have caused her harm. How many women does this effect in the UK each year?
- a. 0-1500
 - b. 1501-3000
 - c. 3001-4500
 - d. 4501-6000
 - e. Other _____ (please specify)
 - f. Don't know
7. Are there negative consequences of breast screening?
- a. Yes
 - b. No
 - c. Don't know
8. Out of 100 women aged 50 or over who are invited to screening in the UK each year, how many people are told they need more tests and later find out they do not have cancer?
- a. 0

- b. 1
- c. 2
- d. 3
- e. 4
- f. 5
- g. 5+
- h. Other _____ (please specify)
- i. Don't know

9. Is breast screening compulsory? *(please circle)*

- a. Yes
- b. No
- c. Don't know

Attitudes

Your thoughts about the screening test will be measured now.

For the following statements below please circle a number from 1 to 5 on the scale that best describes how you feel at the moment. Please read the scale for each question.

For example in question 1(a) if you thought having the screening test would be very useful, you would circle 1. If you thought it was a worthless thing you would circle 5. If you did not have a strong opinion either way you would circle 3.

1. For me, having a *mammogram* for breast cancer will be:

Useful	1	2	3	4	5	Worthless
Beneficial	1	2	3	4	5	Harmful
Essential	1	2	3	4	5	Inappropriate
Good thing	1	2	3	4	5	Bad thing
Not embarrassing	1	2	3	4	5	Embarrassing
Easy	1	2	3	4	5	Difficult

My own choice	1	2	3	4	5	Something I have to do
------------------	---	---	---	---	---	---------------------------

2. Please only complete this question if you have attended a mammogram appointment before.

For me, when I receive a mammogram I feel:

Comfortable	1	2	3	4	5	Uncomfortable
-------------	---	---	---	---	---	---------------

No pain	1	2	3	4	5	Pain
---------	---	---	---	---	---	------

Healthy	1	2	3	4	5	Unhealthy
---------	---	---	---	---	---	-----------

Not embarrassed	1	2	3	4	5	Embarrassed
--------------------	---	---	---	---	---	-------------

3. In the next five years, how likely do you think it is that you will be diagnosed with breast cancer?

Very unlikely	1	2	3	4	5	6	7	Very likely
------------------	---	---	---	---	---	---	---	-------------

4. What do you think your risk of developing breast cancer is in your lifetime?

Very unlikely	1	2	3	4	5	6	7	Very likely
------------------	---	---	---	---	---	---	---	-------------

Behaviour

1. Have you attended a previous breast screening appointment within the last three years?
 - a. Yes
 - b. No
2. Have you ever had a mammogram?
 - a. Yes
 - b. No

C. Personal Characteristics

This section will be asking some questions about you. This is so that we can recognise which group of the population you belong to. Remember this questionnaire is anonymous and your answers cannot be linked back to you so please be as accurate as you can.

1. What is your date of birth? ____ / ____ / ____ (DD/MM/YYYY)
2. What is your postcode? _____
3. How would you describe your ethnicity? *(please circle)*
 - a. White British
 - b. White Other
 - c. White and Black Caribbean
 - d. White and Black African
 - e. White and Asian
 - f. Mixed other (please specify) _____
 - g. Indian
 - h. Pakistani
 - i. Bangladeshi
 - j. Chinese
 - k. Asian other (please specify) _____
 - l. African
 - m. Caribbean
 - n. Black other (please specify) _____
 - o. Other (please specify) _____
4. How would you describe yourself? *(please circle)*
 - a. Single
 - b. Cohabiting with partner
 - c. Married or civil partnered
 - d. Divorced
 - e. Widowed
5. In which of these ways does your household occupy your accommodation? *(please circle)*
 - a. Owned
 - b. Buying with help of a mortgage or loan

- c. Pay part rent part mortgage (shared ownership)
 - d. Rent it
 - e. Live here rent free
 - f. Squatting
 - g. Homeless
6. What is the highest level of education you have completed? *(please circle)*
- a. University or college equivalent
 - b. Intermediate between secondary level and university (e.g. technical training)
 - c. Secondary school
 - d. Primary school only (or less)
7. Which of these descriptions applies to you for the last seven days? *(please circle)*
- a. In paid employment or self-employed
 - b. Permanently unable to work due to long-term sickness or disability
 - c. Retired
 - d. Looking after home and/or family
 - e. Never had work or been employed
 - f. Other (please specify) _____

If you circled answer (e) please proceed to question 7.

8. How would you describe your last employment role? *(please circle)*
- a. Managerial and professional occupations
 - b. Intermediate occupations
 - c. Small employers and own account workers
 - d. Lower supervisory and technical occupations
 - e. Semi-routine and routine occupations
 - f. Other (please specify) _____
 - g. Unknown
9. How much does your household take home each year? *(please circle)*
- a. Up to £15,000
 - b. £15,001 to £25,000
 - c. £25,001 to £35,000
 - d. £35,001 to £45,000

- e. £45,001 to £55,000
- f. More than £55,001
- g. Prefer not to say
- h. Unknown

10. Do you consider to have any conditions or illnesses that affect you? *(please circle)*

- a. Yes (please continue)
- b. No (please go to question 12)

11. Do any of your conditions or illnesses affect you in the any of the following areas *(please tick all that apply)*

- a. Vision (for example blindness or partial sight) ☐
- b. Hearing (for example deafness or partial hearing) ☐
- c. Mobility (for example walking short distances or climbing stairs) ☐
- d. Dexterity (for example lifting and carrying objects or using a computer) ☐
- e. Learning or understanding or concentrating ☐
- f. Memory ☐
- g. Mental health (for example depression, schizophrenia or anxiety) ☐
- h. Stamina or breathing or fatigue ☐
- i. Socially or behaviourally (for example autism, attention deficit disorder or Asperger's syndrome) ☐
- j. Other (please specify) _____ ☐
- k. Would prefer not to say ☐

8.4.3 Questionnaire (post PPI)

Thank you for agreeing to participate in this questionnaire study. The following questions will ask a number of detailed questions about your and your family's medical history.

These questions are asked to assess different factors that may influence participation at breast screening. These questions may seem very detailed and you may be wondering why we need so much information about your family medical background. The reason is that one of our ideas is that a woman's decision to participate in breast screening may be affected by her own perceived risk of breast cancer. Anecdotally, we know that some women may feel that their own risk of breast cancer

may be affected by factors such as bodyweight, age of first period, giving birth and having female family members who have had had cancer. Hence, we ask a number of detailed questions in these areas. Not everything that we ask are about risk factors of cancer.

Your answers are anonymous and will be kept confidential. Your answers will be used in the future research that may influence the breast screening programme. We appreciate you helping with our research and would like to thank you in advance for your time taken to complete this questionnaire.

Medical factors that may influence uptake

In this section the questions asked are specific to your medical history. Some, but not all, are risk factors associated with cancer. Please answer as carefully and accurately as you can. However, if you do not know exactly, please estimate where you can.

1. How tall are you without shoes? _____cm **or** _____ft_____inches

2. How much do you weigh unclothed? _____kg **or** _____stone _____pounds

3. Have you given birth? *(please tick one answer)*

- a. Yes (please continue) ☐
- b. No (please go to question 5) ☐

4. How old were you at the birth of your first child? _____ (years)

5. How old were you when your first period started? _____ (years)

6. When was your last period (i.e. no monthly bleeding)? *(please tick one answer)*

- a. Last month (please go to question 11) ☐
- b. Up to six months ago ☐
- c. Six months to one year ago ☐
- d. 1 year ago ☐
- e. 1-2 years ago ☐
- f. 2-5 years ago ☐
- g. More than 5 years ago ☐
- h. Don't know ☐

7. How old were you when you started to go through the menopause?

_____ (years)

8. Have you ever used hormone replacement therapy (HRT)? *(please tick one answer)*

- a. Yes (please continue) ☐
- b. No (please go to question 11) ☐

9. When did you last use hormone replacement therapy? *(please tick one answer)*

- a. 5 or more years ago ☐
- b. Within the last five years ☐
- c. I am a current user ☐

10. How long did you use hormone replacement therapy for in total? _____ years

11. Have you previously been diagnosed with any of the following? *(please tick all that apply)*

- a. Prior biopsy conducted, result unknown ☐
- b. Hyperplasia (not atypical) ☐
- c. Atypical hyperplasia ☐
- d. Lobular carcinoma in situ (LCIS) ☐
- e. Breast cancer ☐
- f. Ductal carcinoma in situ (DCIS) ☐
- g. No ☐

For this questionnaire, we're only interested in blood relatives (not people related to you by marriage).
We are also only interested in the medical history of your female relatives.

12. Have any blood relatives been diagnosed with breast cancer? *(please tick one answer)*

- c. Yes (please continue) ☐
- d. No (please go to question 14) ☐

13. If you answered yes, we need some more specific information about how the relative with a breast cancer diagnosis is related to you. Please complete the table below to your best ability identifying which relatives were diagnosed with breast cancer, at what age and if this cancer was present in both breasts (bilateral)? It would be really useful to be as accurate as you can. However if you cannot remember how old your family member was at diagnosis please

estimate her decade for instance if she was about 53 years old you would enter 50 years, if she was about 58 you would enter 60 years. *(please complete for all relatives that this applies)*

Family Member	Diagnosed with Breast Cancer? (yes/no)	At what age? (years)	Was this bilateral breast cancer? (yes/no)
Mother			
Sister(s) Please use a new line for each sister			
Paternal Grandmother (father's mother)			
Maternal Grandmother (mother's mother)			
Paternal aunt(s) (father's sister) Please use a new line for each aunt			
Maternal aunt(s) (mother's sister) Please use a new line for each aunt			
Daughter(s) Please use a new line for each daughter			
For the below relatives please provide detail on your family linkage.			
Please use a new line for each affected half-sister: Father's side Mother's side			
Please use a new line for each affected cousin: Father's side Mother's side			

Please use a new line for each affected niece: Father's side			
Mother's side			

14. Have you or anyone in your family been genetically tested for BRCA1 or BRCA2 genes? *(please tick one answer)*

- a. Yes (please continue) ☐
- b. No (please go to question 16) ☐
- c. Don't know (please go to question 16) ☐

15. If you know the results, please indicate them below. Please remember, we are only interested in your blood relatives.

Family Member	Negative result	BRCA1 positive	BRCA2 positive
Individual (you)			
Father			
Mother			
Sister(s) Please use a new line for each sister			
Daughter(s) Please use a new line for each daughter			
Paternal Grandmother (father's mother)			
Maternal Grandmother (mother's mother)			
Paternal aunt (father's sister)			
Maternal aunt (mother's sister)			

16. Have any relatives been diagnosed with ovarian cancer? *(please tick one answer)*

- a. Yes (please continue) ☐
- b. No (please go to question 18) ☐

17. If you answered yes, we need some more specific information about how the diagnosis is related to you. Please complete the table below to your best ability identifying which relatives

were diagnosed with ovarian cancer and at what age? It would be really useful to be as accurate as you can. However if you cannot remember how old your family member was at diagnosis please estimate her decade for instance if she was about 53 years old you would enter 50 years, if she was about 58 you would enter 60 years. *(please complete for all relatives that this applies)*

For this questionnaire, we're only interested in blood relatives (not people related to you by marriage).

Family Member	Diagnosed with Ovarian cancer? (yes/no)	At what age? (years)
Mother		
Sister(s) (Please use a new line for each sister)		
Paternal Grandmother (your fathers mother)		
Maternal Grandmother (your mothers' mother)		
Paternal aunt(s) Please use a new line for each aunt		
Maternal aunt(s) (your mothers sister) Please use a new line for each aunt		
Daughter(s) Please use a new line for each daughter		
For the below relatives please provide detail on your family linkage.		
Please use a new line for each affected half-sister: Father's side Mother's side		
Please use a new line for each affected cousin:		

Father's side		
Mother's side		
Please use a new line for each affected niece: Father's side		
Mother's side		

Knowledge, attitudes and behaviour

The questions asked in this section are based on previous research which indicates that a woman's knowledge, attitudes and behaviour towards screening may be factors that could influence participation in screening. Please remember we are not testing you and your answers will not affect any healthcare you are receiving.

This part of the questionnaire is asking about your background knowledge and perceptions about breast screening. You will not be judged by right or wrong answers.

To help you complete the next part of the questionnaire, a 'mammogram' is the term used for the x-ray taken during the breast screening appointment.

18. What do you think screening is used for? *(please tick one answer)*

- d. To test what is wrong with unhealthy people ☐
- e. To find illnesses in currently healthy people ☐
- f. To determine who deserves treatment and who does not ☐
- g. Don't know ☐

19. What do you think a screening mammogram is for? *(please tick one answer)*

- a. Detects if cancer is present in those who have a lump in their breast ☐
- b. Checks for signs of breast cancer in healthy women ☐
- c. Don't know ☐

20. Do you believe every woman with a 'positive' mammogram result has breast cancer? *(please tick one answer)*

- a. Yes ☐
- b. No ☐
- c. Don't know ☐

21. What do you think it means if a woman receives a 'negative' mammogram result? *(please tick one answer)*

- a. She will not get cancer in the future ☐
- b. The mammogram did not work ☐
- c. She does not have cancer that can be detected at the moment ☐
- d. Don't know ☐

22. Which groups do you believe have the highest rates of breast cancer detection? *(please tick one answer)*

- a. Women who attend screening ☐
- b. Women who do not attend screening ☐
- c. Don't know ☐

23. Some women are diagnosed with a cancer that never would have caused her harm. How many women do you think this affects in the UK each year? *(please tick one answer)*

- a. 0-1500 ☐
- b. 1501-3000 ☐
- c. 3001-4500 ☐
- d. 4501-6000 ☐
- e. Other _____ (please specify) ☐
- f. Don't know ☐

24. Do you think there are negative consequences of breast screening? *(please tick one answer)*

- a. Yes ☐
- b. No ☐
- c. Don't know ☐

25. Out of 100 women aged 50 or over who are invited to screening in the UK each year, how many people do you think are told they need more tests and later find out they do not have cancer? *(please tick one answer)*

- a. 0-2 ☐
- b. 2-4 ☐
- c. 4-6 ☐
- ☐

- d. 6-8
 - e. 8-10
 - f. More than 10
 - g. Don't know
- ☐
☐
☐

26. Do you think breast screening is compulsory? *(please tick one answer)*

- a. Yes
 - b. No
 - c. Don't know
- ☐
☐
☐

We will now ask a number of questions to capture your thoughts about the mammogram and the experience.

For the following statements below please circle a number from 1 to 5 on the scale that best describes how you feel at the moment. Please read the scale for each question.

For example in the first part if you thought having the screening test would be very useful, you would circle 5. If you thought it was a worthless thing you would circle 1. If you did not have a strong opinion either way you would circle 3.

27. Even if you have not had a mammogram before please answer how you feel about the idea of having one.

For me, having a mammogram for breast cancer will be:

Worthless	1	2	3	4	5	Useful
Harmful to health	1	2	3	4	5	Beneficial to health

Not necessary	1	2	3	4	5	Essential
Will be a bad thing	1	2	3	4	5	Will be a good thing
Embarrassing	1	2	3	4	5	Not embarrassing
Difficult	1	2	3	4	5	Easy
Something I feel I have to do	1	2	3	4	5	I'd be willing to go

28. Have you ever had a mammogram? *(please tick one answer)*

c. Yes

☐

d. No (please go to question 32)

☐

29. Have you attended a previous breast screening appointment within the last three years?

(please tick one answer)

a. Yes

☐

b. No

☐

30. Have you ever done the following? *(please tick all that apply)*

a. Delayed or re-scheduled a breast screening appointment

☐

b. Permanently withdrawn from the breast screening programme

☐

c. Other (please specify)

d. None of the above

☐

31. Please only complete this question if you have attended a mammogram appointment before.

For me, when I receive a mammogram I feel:

Uncomfortable	1	2	3	4	5	Comfortable
Pain	1	2	3	4	5	No pain
In poor health	1	2	3	4	5	In good health

Shy 1 2 3 4 5 Not shy

32. In the next five years, how likely do you think it is that you will be diagnosed with breast cancer?

Very unlikely 1 2 3 4 5 6 7 Very likely

33. What do you think your risk of developing breast cancer is in your lifetime?

Very unlikely 1 2 3 4 5 6 7 Very likely

Personal Characteristics

This section will be asking some questions about you. This is so that we can recognise which group of the population you belong to. Remember this questionnaire is anonymous and your answers cannot be linked back to you in any way so please be as accurate as you can.

34. What is your date of birth? ____ / ____ / ____ (DD/MM/YYYY)

35. What is your postcode? ____ _

36. How would you describe your ethnicity? *(please tick one answer)*

l. White British

☐

m. White Other

☐

n. White and Black Caribbean

☐

o. White and Black African

☐

p. White and Asian

☐

q. Mixed other (please specify) _____

☐

r. Indian

☐

s. Pakistani

☐

t. Bangladeshi

☐

- u. Chinese ☐
- v. Asian other (please specify) _____ ☐
- w. African ☐
- x. Caribbean ☐
- y. Black other (please specify) _____ ☐
- z. Other (please specify) _____ ☐

37. How would you describe yourself? *(please tick one answer)*

- a. Single ☐
- b. Cohabiting with partner ☐
- c. Married or civil partnered ☐
- d. Divorced ☐
- e. Widowed ☐

38. Your household is defined as anyone you live with and share a joint budget. In which of these ways do you or your household occupy your accommodation? *(please tick one answer)*

- a. Own outright ☐
 - b. Bought with a mortgage or loan ☐
 - c. Pay part rent part mortgage (shared ownership) ☐
 - d. Renting ☐
 - e. Living rent free ☐
 - f. Squatting ☐
 - g. Homeless ☐
 - h. Contribute to expenses in someone else's house ☐
- (For example living in parent's or friend's house)

39. What is the highest level of education you have completed? *(please tick one answer)*

- a. University ☐
- b. Intermediate between secondary level and university ☐
- (e.g. technical training or college)
- c. Secondary school ☐
- d. Primary school only (or less) ☐

40. Which of these descriptions applies to you for the last seven days? *(please circle)*

- a. In paid employment or self-employed ☐
- ☐

- b. Permanently unable to work due to long-term sickness or disability ☐
- c. Retired ☐
- d. Looking after home and/or family ☐
- e. Never had work or been employed (please go to question 42) ☐
- f. Other (please specify) _____ ☐

If you circled answer (e) please proceed to question 42.

41. Which option best describes your last employment role? *(please tick one answer)*

- a. Self-employed ☐
- b. Salaried employment ☐
- c. Zero hour contract work ☐
- d. Short term contract work ☐
- e. Other (please specify) _____ ☐

42. How much does your household take home each year? Your household is defined as anyone you live with and share a joint financial responsibility. *(please tick one answer)*

- a. Up to £15,000 ☐
- b. £15,001 to £25,000 ☐
- c. £25,001 to £35,000 ☐
- d. £35,001 to £45,000 ☐
- e. £45,001 to £55,000 ☐
- f. More than £55,001 ☐
- g. Prefer not to say ☐
- h. Unknown ☐

43. Do you consider yourself as having any conditions or illnesses that affect you? *(please tick one answer)*

a. Yes (please continue to question 44)

☐

b. No

☐

44. Do any of your conditions or illnesses affect you in any of the following areas? *(please tick all that apply)*

a. Vision (for example blindness or partial sight)

☐

b. Hearing (for example deafness or partial hearing)

☐

c. Mobility (for example walking short distances or climbing stairs)

☐

d. Dexterity (for example lifting and carrying objects or using a computer)

☐

e. Learning or understanding or concentrating

☐

f. Memory

☐

g. Mental health (for example depression, schizophrenia or anxiety)

☐

h. Stamina or breathing or fatigue

☐

i. Socially or behaviourally (for example autism, attention deficit disorder or Asperger's syndrome)

☐

j. Other (please specify) _____

☐

k. Would prefer not to say

☐

Thank you for taking the time to complete this questionnaire and send it back to us, it is really appreciated and your answers will be very useful for our research.

8.4.4 Ethical approval



PRIVATE
Miss Rebecca Crosby
Warwick Medical School
University of Warwick
Coventry
CV4 7AL

3 January 2018

Dear Miss Crosby

Study Title and BSREC Reference: *Predictors of Attendance. A questionnaire study*
REGO-2017-2118

Thank you for submitting the revisions to the above-named study to the University of Warwick's Biomedical and Scientific Research Ethics Sub-Committee for approval.

I am pleased to confirm that approval is granted and that your study may commence.

In undertaking your study, you are required to comply with the University of Warwick's *Research Data Management Policy*, details of which may be found on the Research and Impact Services' webpages, under "Codes of Practice & Policies" » "Research Code of Practice" » "Data & Records" » "Research Data Management Policy", at:
http://www2.warwick.ac.uk/services/ris/research_integrity/code_of_practice_and_policies/research_code_of_practice/datacollection_retention/research_data_mgt_policy

You are also required to comply with the University of Warwick's *Information Classification and Handling Procedure*, details of which may be found on the University's Governance webpages, under "Governance" » "Information Security" » "Information Classification and Handling Procedure", at:


<http://www2.warwick.ac.uk/services/gov/informationsecurity/handling>.
Investigators should familiarise themselves with the classifications of information defined therein, and the requirements for the storage and transportation of information within the different classifications:

Information Classifications:
<http://www2.warwick.ac.uk/services/gov/informationsecurity/handling/classifications>
Handling Electronic Information:
<http://www2.warwick.ac.uk/services/gov/informationsecurity/handling/electronic/>
Handling Paper or other media
<http://www2.warwick.ac.uk/services/gov/informationsecurity/handling/paper/>.

Please also be aware that BSREC grants ethical approval for studies. The seeking and obtaining of all other necessary approvals is the responsibility of the investigator.

These other approvals may include, but are not limited to:

www.warwick.ac.uk

- 
1. Any necessary agreements, approvals, or permissions required in order to comply with the University of Warwick's Financial Regulations and Procedures.
 2. Any necessary approval or permission required in order to comply with the University of Warwick's Quality Management System and Standard Operating Procedures for the governance, acquisition, storage, use, and disposal of human samples for research.
 3. All relevant University, Faculty, and Divisional/Departmental approvals, if an employee or student of the University of Warwick.
 4. Approval from the applicant's academic supervisor and course/module leader (as appropriate), if a student of the University of Warwick.
 5. NHS Trust R&D Management Approval, for research studies undertaken in NHS Trusts.
 6. NHS Trust Clinical Audit Approval, for clinical audit studies undertaken in NHS Trusts.
 7. Approval from Departmental or Divisional Heads, as required under local procedures, within Health and Social Care organisations hosting the study.
 8. Local ethical approval for studies undertaken overseas, or in other HE institutions in the UK.
 9. Approval from Heads (or delegates thereof) of UK Medical Schools, for studies involving medical students as participants.
 10. Permission from Warwick Medical School to access medical students or medical student data for research or evaluation purposes.
 11. NHS Trust Caldicott Guardian Approval, for studies where identifiable data is being transferred outside of the direct clinical care team. Individual NHS Trust procedures vary in their implementation of Caldicott guidance, and local guidance must be sought.
 12. Any other approval required by the institution hosting the study, or by the applicant's employer.

There is no requirement to supply documentary evidence of any of the above to BSREC, but applicants should hold such evidence in their Study Master File for University of Warwick auditing and monitoring purposes. You may be required to supply evidence of any necessary approvals to other University functions, e.g. The Finance Office, Research & Impact Services (RIS), or your Department/School.

May I take this opportunity to wish you success with your study, and to remind you that any Substantial Amendments to your study require approval from BSREC before they may be implemented.

Yours sincerely

pp.

Dr David Ellard
Chair
Biomedical and Scientific
Research Ethics Sub-Committee

Biomedical and Scientific
Research Ethics Sub-Committee
Research & Impact Services
University of Warwick
Coventry, CV4 8UW.
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[http://www2.warwick.ac.uk/services/
ris/research_integrity/researchethics
committees/biomed](http://www2.warwick.ac.uk/services/ris/research_integrity/researchethicscommittees/biomed)

PRIVATE
Miss Rebecca Crosby
Warwick Medical School
University of Warwick
Coventry
CV4 7AL

24 May 2018

Dear Miss Crosby

Study Title and BSREC Reference: *Predictors of Attendance. A questionnaire study*
REGO-2017-2118 AM01

Thank you for submitting a substantial amendment application for the above-named project to the University of Warwick's Biomedical and Scientific Research Ethics Sub-Committee.

I am pleased to confirm that the changes that you wish to make to this study have been approved.

Please keep a copy of the signed version of this letter with your study documentation.

Yours sincerely

pp.

Dr David Ellard
Chair
Biomedical and Scientific
Research Ethics Sub-Committee

Biomedical and Scientific
Research Ethics Sub-Committee
Research & Impact Services
University of Warwick
Coventry, CV4 8UW.
E: BSREC@Warwick.ac.uk

[http://www2.warwick.ac.uk/services/
ris/research_integrity/researchethics
committees/biomed](http://www2.warwick.ac.uk/services/ris/research_integrity/researchethicscommittees/biomed)

www.warwick.ac.uk

8.4.5 Final draft questionnaire

Predictors of Attendance. A questionnaire development study.

Thank you for agreeing to participate in this study. It should take you no more than 15 minutes.

Your answers will be kept confidential. Your answers will be used in future research. The results of this research may influence the breast screening programme. We appreciate you helping with our research and would like to thank you in advance for your time taken to complete this questionnaire.

The following questions will ask about your and your family's medical history to assess factors that may influence participation at breast screening. Not everything we ask is about risk factors of cancer. They are designed to identify factors that might influence participation at breast screening

Medical factors that may influence uptake

In this section the questions asked are specific to your medical history. Some, but not all, are risk factors associated with cancer. Please answer as carefully and accurately as you can. If you do not know exactly, please estimate where you can.

1. How tall are you without shoes? _____ cm **or** _____ ft _____ inches
2. How much do you weigh unclothed? _____ kg **or** _____ stone _____ pounds
3. Have you given birth? *(please tick one answer)*
 - a. Yes (please go to question 4) ☐
 - b. No (please go to question 5) ☐
4. How old were you at the birth of your first child (or twins)? _____ (years)
5. How old were you when your first period started? _____ (years)

6. When was your last period (i.e. monthly bleeding)? *(please tick one answer)*

- a. Last month (please go to question 13) ☐
- b. One to five months ago ☐
- c. Six months to one year ago ☐
- d. 1-2 years ago ☐
- e. 3-5 years ago ☐
- f. More than 5 years ago ☐
- g. Don't know ☐

7. Was this monthly bleed hormone induced (i.e. because you take hormone replacement therapy)?

- a. Yes ☐
- b. No ☐

8. How old were you when you started to go through the menopause? Menopause is defined as when there has been no menstrual periods for 12 months consecutively and no other cause is identified.

_____ (years)

9. Would you describe yourself as peri-menopausal? This is defined as a time where you experience menopause-like symptoms but have had a menstrual period within the last 12 months.

- a. Yes ☐
- b. No ☐

10. Have you ever used hormone replacement therapy (HRT)? *(please tick one answer)*

- a. Yes (please go to question 11) ☐
- b. No (please go to question 13) ☐
- c. HRT is not a medical option for me ☐

11. When did you last use hormone replacement therapy? *(please tick one answer)*

- a. 5 or more years ago ☐
- b. Within the last five years ☐
- c. I am a current user ☐

12. How long did you use hormone replacement therapy for in total?

- a. 1-2 months ☐
- b. 3-6 months ☐
- c. 7-12 months ☐
- d. 1 year ☐
- e. 2 years ☐
- f. 3 years ☐
- g. 4 years ☐
- h. 5+ years ☐

13. Have you previously been diagnosed with any of the following? *(please tick all that apply)*

- a. Prior breast biopsy conducted, result unknown ☐
- b. Hyperplasia (not atypical) (an increase in number of cells in the breast, it can occur naturally and is not cancer) ☐
- c. Atypical hyperplasia (the cells in the breast increase in number and also develop in an unusual pattern or shape) ☐
- d. Lobular carcinoma in situ (LCIS) (an area of abnormal cell growth that increases a person's risk of developing invasive breast cancer later in life) ☐
- e. Breast cancer ☐
- f. Ductal carcinoma in situ (DCIS) (the cells in the lining of the duct of the breast tissue have started to turn into cancer cells. These cells have not started to spread into the surrounding breast tissue) ☐
- g. Fibroadenosis (painful condition of lumpy breast tissue) ☐

For this questionnaire, we are only interested in blood relatives (not people related to you by marriage).

14. Have any blood relatives been diagnosed with breast cancer? *(please tick one answer)*

e. Yes (please go to question 15)

☐

f. No (please go to question 16)

☐

15. If you answered yes, we need some more specific information about how the relative with a breast cancer diagnosis is related to you. Please complete the table below as best you can identifying which relatives were diagnosed with breast cancer, at what age and if this cancer was present in both breasts? If you cannot remember how old your family member was at diagnosis please estimate to the nearest decade. For example, if she was about 53 years old enter 50 years, if she was about 58 enter 60 years. *(please complete for all relatives that this applies to)*

Family member	Diagnosed with breast cancer? (yes/no)	At what age? (years)	Was this breast cancer in both breasts? (yes/no)
Mother			
Father			
Sister(s) Please use a new line for each sister			
Brother(s)			
Paternal Grandmother (father's mother)			
Maternal Grandmother (mother's mother)			
Paternal aunt(s) (father's sister) Please use a new line for each aunt			

Maternal aunt(s) (mother's sister) Please use a new line for each aunt			
Daughter(s) Please use a new line for each daughter			
For the below relatives please provide detail on your family linkage.			
Please use a new line for each affected half-sister: Father's side Mother's side			
Please use a new line for each affected cousin: Father's side Mother's side			
Please use a new line for each affected niece: Father's side Mother's side			

16. Have you or anyone in your family been genetically tested for BRCA1 or BRCA2 genes?

(please tick one answer)

- d. Yes (please go to question 17) ☐
- e. No (please go to question 18) ☐
- Please only tick this if you are certain
- f. Don't know (please go to question 18) ☐

17. If you know the results, please indicate them below. Please remember, we are only interested in your blood relatives.

Family Member	Negative result	BRCA1 positive	BRCA2 positive
You			
Father			
Mother			
Sister(s) Please use a new line for each sister			
Daughter(s) Please use a new line for each daughter			
Paternal Grandmother (father's mother)			
Maternal Grandmother (mother's mother)			
Paternal aunt (father's sister)			
Maternal aunt (mother's sister)			

18. Have any of your relatives been diagnosed with ovarian cancer? *(please tick one answer)*

- a. Yes (please go to question 19) ☐
- b. No (please turn to page 8 and continue at question 20) ☐

19. If you answered yes, we need some more specific information about how the person with the diagnosis is related to you. Please complete the table below as best you can identifying which relatives were diagnosed with ovarian cancer and at what age. If you cannot remember how old your family member was at diagnosis please estimate to the nearest decade for example, if she was about 53 years old enter 50 years, if she was about 58 enter 60 years. *(please complete for all relatives that this applies)*

For this questionnaire, we're only interested in blood relatives (not people related to you by marriage).

Family Member	Diagnosed with ovarian cancer? (yes/no)	At what age? (years)
Mother		
Sister(s) (Please use a new line for each sister)		
Paternal Grandmother (your fathers mother)		
Maternal Grandmother (your mothers' mother)		
Paternal aunt(s) Please use a new line for each aunt		
Maternal aunt(s) (your mothers sister) Please use a new line for each aunt		
Daughter(s) Please use a new line for each daughter		
For the below relatives please provide detail on your family linkage.		
Please use a new line for each affected half-sister: Father's side		

Mother's side		
Please use a new line for each affected niece: Father's side		
Mother's side		

Knowledge, attitudes and behaviour

The questions asked in this section are based on previous research which indicates that a woman's knowledge, attitudes and behaviour towards screening might influence her participation in screening. Please remember we are not testing you and your answers will not affect any healthcare you are receiving.

This part of the questionnaire is asking about your current knowledge and perceptions about breast screening. You will not be judged by right or wrong answers.

To help you complete the next part of the questionnaire, a 'mammogram' is the term used for the x-ray taken during the breast screening appointment.

20. What do you think population screening programme is used for? *(please tick one answer)*

- h. To test what is wrong with unhealthy people ☐
- i. To identify increased risk of disease in apparently healthy people ☐
- j. To determine who requires treatment and who does not ☐
- k. Don't know ☐

21. What do you think the population breast screening programme is for? *(please tick one answer)*

- d. Detects if cancer is present in those who have a lump in their breast ☐
- e. Checks for signs of breast cancer in healthy women ☐
- f. Both a and b ☐
- g. Don't know ☐

22. Do you believe every woman with a 'positive' mammogram result has breast cancer?

(please tick one answer)

- d. Yes ☐
- e. No ☐
- f. Don't know ☐

23. What do you think it means if a woman receives a 'negative' mammogram result? *(please*

tick one answer)

- e. She will not get cancer in the future ☐
- f. The mammogram did not work ☐
- g. To the best of the screener's knowledge, she does not have cancer that can be detected at the moment but it may still be present ☐
- h. She does not have cancer ☐
- i. Don't know ☐

24. Which groups do you believe have the highest rates of breast cancer? *(please tick one answer)*

- d. Women who attend screening ☐
- e. Women who do not attend screening ☐
- f. Don't know ☐

25. Some women are diagnosed with a breast cancer that never would have caused her harm. For every one women who has her life saved from breast cancer how many women are believed to be overdiagnosed with a cancer that would never have become life-threatening? *(please tick one answer)*

- g. 0 ☐
- h. 1 ☐
- i. 2 ☐
- j. 3 ☐
- k. Other _____ (please specify) ☐
- l. Don't know ☐

26. Do you think there are negative consequences of breast screening? *(please tick one answer)*

d. Yes – there are negative consequences (please go to question 27)

☐

e. No – there are no negative consequences (please go to question 28)

☐

f. Don't know

☐

27. What do you think the negative consequences of breast screening are?

28. Why do you think there are no negative consequences of breast screening?

29. Out of 100 women aged 50 or over who are invited to screening in the UK each year, how many do you think have further tests but later find out they do not have cancer?

(please tick one answer)

h. 0

☐

i. 1-2

☐

j. 3-4

☐

k. 7-8

☐

l. 9-10

☐

m. 11 or more

☐

n. Don't know

☐

30. Have you had any friends diagnosed with breast cancer?

a. Yes

☐

b. No

☐

31. Do you think there is a legal requirement to attend breast screening? *(please tick one answer)*

d. Yes

☐

e. No

☐

f. Don't know

☐

The following questions are about views and experience of mammograms

For the following statements below please circle a number from 1 to 5 on the scale that best describes how you feel at the moment. Please read the scale for each question.

For example in the first part if you thought having the screening test would be very useful, you would circle 5. If you thought it was a worthless thing you would circle 1. If you did not have a strong opinion either way you would circle 3.

32. Even if you have not had a mammogram before please answer how you feel about the idea of having one.

For me, having a mammogram for breast cancer will be:

Worthless	1	2	3	4	5	Useful
Beneficial to health	1	2	3	4	5	Harmful to health
Not necessary	1	2	3	4	5	Essential
Will be a good thing	1	2	3	4	5	Will be a bad thing
Embarrassing	1	2	3	4	5	Not embarrassing
Difficult to access	1	2	3	4	5	Easy to access
Something I feel I have to do	1	2	3	4	5	Something I don't feel I have to do

33. Have you ever had a mammogram? *(please tick one answer)*

e. Yes (please go to question 35)

☐

f. No (please go to question 34)

☐

34. Why did you not attend?

a. Inconvenient time

☐

b. Inconvenient location

☐

c. I don't want to be screened

☐

d. I'm embarrassed or shy

☐

e. Other (please specify) _____

35. Have you attended a mammogram within the last three years? *(please tick one answer)*

c. Yes

☐

d. No

☐

36. Have you ever done the following? *(please tick all that apply)*

e. Delayed or re-scheduled a breast screening appointment

☐

f. Permanently withdrawn from the breast screening programme

☐

g. None of the above

☐

37. Please circle the statement you agree with most for the following statements:

If you have had a mammogram before please complete this question answering "For me, when I have a mammogram I feel..."

If you have not had a mammogram before, please complete this question answering "For me, if I had a mammogram I think I would be..."

Physically Uncomfortable	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly disagree
In pain	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
Shy	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly disagree
In poor health	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree

38. In the next five years, how likely do you think it is that you will be diagnosed with breast cancer or breast cancer recurrence?

Very unlikely	1	2	3	4	5	6	7	Very likely
------------------	---	---	---	---	---	---	---	----------------

39. How likely do you think it is that you will develop breast cancer (or breast cancer will reoccur) in your lifetime?

Very unlikely	1	2	3	4	5	6	7	Very likely
------------------	---	---	---	---	---	---	---	----------------

Personal Characteristics

This section will be asking some questions about you. This is so that we can recognise which group of the population you belong to. Remember this questionnaire is anonymous and your answers cannot be linked back to you in any way so please be as accurate as you can.

40. What is your year of birth? ____ ____ ____ ____ (YYYY)

41. What is the first part of your postcode? ____ ____ ____ ____

42. How would you describe your ethnicity? *(please tick one answer)*

aa. White British

☐

bb. White Other

☐

cc. White and Black Caribbean

☐

dd. White and Black African

☐

ee. White and Asian

☐

ff. Indian

☐

gg. Pakistani

☐

hh. Bangladeshi

☐

ii. Chinese

☐

jj. African

☐

kk. Caribbean

☐

ll. Other

☐

43. How would you describe yourself? *(please tick one answer)*

- | | |
|--------------------------------------|--------------------------|
| f. Single | <input type="checkbox"/> |
| g. Cohabiting with partner | <input type="checkbox"/> |
| h. Married or civil partnered | <input type="checkbox"/> |
| i. Divorced | <input type="checkbox"/> |
| j. Widowed | <input type="checkbox"/> |
| k. In a relationship, not cohabiting | <input type="checkbox"/> |

44. How would you describe your living arrangements? *(please tick one answer)*

- | | |
|---|--------------------------|
| i. Own outright | <input type="checkbox"/> |
| j. Bought with a mortgage or other loan | <input type="checkbox"/> |
| k. Pay part rent part mortgage (shared ownership) | <input type="checkbox"/> |
| l. Renting | <input type="checkbox"/> |
| m. Living rent free | <input type="checkbox"/> |
| n. Squatting | <input type="checkbox"/> |
| o. Homeless | <input type="checkbox"/> |
| p. Contribute to expenses in someone else's house | <input type="checkbox"/> |
- (For example living in parent's or friend's house)

45. What is the highest level of education you have completed? *(please tick one answer)*

- | | |
|--|--------------------------|
| e. University | <input type="checkbox"/> |
| f. Intermediate between secondary level and university
(e.g. technical training or college) | <input type="checkbox"/> |
| g. Secondary school | <input type="checkbox"/> |
| h. Primary school only (or less) | <input type="checkbox"/> |

46. How would you describe your current employment status? *(please tick all that apply)*

- | | |
|---|--------------------------|
| g. Full time work (35 hours or more every seven days) | <input type="checkbox"/> |
| h. Part time work (less than 35 hours every seven days) | <input type="checkbox"/> |
| i. Self-employed | <input type="checkbox"/> |
| j. In education full time | <input type="checkbox"/> |
| k. In education part time | <input type="checkbox"/> |
| l. Permanently unable to work due to long-term sickness or disability | <input type="checkbox"/> |
| m. Retired completely | <input type="checkbox"/> |
| n. Working intermittently | <input type="checkbox"/> |
| o. Looking after home and/or family | <input type="checkbox"/> |
| p. Never had work or been employed | <input type="checkbox"/> |
| q. Other (please specify) _____ | <input type="checkbox"/> |

47. How much does your household take home each year after tax? Your household is defined as anyone you live with and share a joint financial responsibility. *(please tick one answer)*

- | | |
|-----------------------|--------------------------|
| i. Up to £15,000 | <input type="checkbox"/> |
| j. £15,001 to £25,000 | <input type="checkbox"/> |
| k. £25,001 to £35,000 | <input type="checkbox"/> |
| l. £35,001 to £45,000 | <input type="checkbox"/> |
| m. £45,001 to £55,000 | <input type="checkbox"/> |
| n. More than £55,001 | <input type="checkbox"/> |
| o. Prefer not to say | <input type="checkbox"/> |
| p. Unknown | <input type="checkbox"/> |

48. Do you suffer from any conditions or illnesses in any of the following areas? The following are examples only and are not the only conditions we are interested in. *(please tick all that apply)*

- l. Vision (e.g. blindness or partial sight that cannot be corrected by reading glasses) ☐
- m. Hearing (e.g. deafness or partial hearing) ☐
- n. Mobility (e.g. walking short distances or climbing stairs) ☐
- o. Dexterity (e.g. lifting and carrying objects or using a computer) ☐
- p. Learning or understanding or concentrating ☐
- q. Memory ☐
- r. Mental health (e.g. depression, schizophrenia or anxiety) ☐
- s. Stamina or breathing or fatigue ☐
- t. Socially or behaviourally (e.g. autism, attention deficit disorder or Asperger's syndrome) ☐
- u. Other (please specify) _____ ☐
- v. Would prefer not to say ☐

49. In what areas do the conditions you mentioned before affect you? *(please tick all that apply)*

- a. Home life ☐
- b. Work life ☐
- c. Daily activities ☐
- d. Social life ☐
- e. Romantic life ☐

Thank you for taking the time to complete this questionnaire and send it back to us, it is really appreciated and your answers will be very useful for our research.

Please return this questionnaire to:

Farmhouse

University of Warwick

Coventry

CV4 7AJ